

U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE

ATTORNEY DOCKET NO.

TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 USC 371

401312

U.S. APPLICATION NO.

097/890103

INTERNATIONAL APPLICATION NO.
PCT/JP99/07230INTERNATIONAL FILING DATE
December 22, 1999

PRIORITY DATE CLAIMED

TITLE OF INVENTION

SENSOR ELEMENT AND METHOD OF FABRICATING THEREOF

APPLICANT(S) FOR DO/EO/US

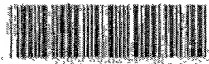
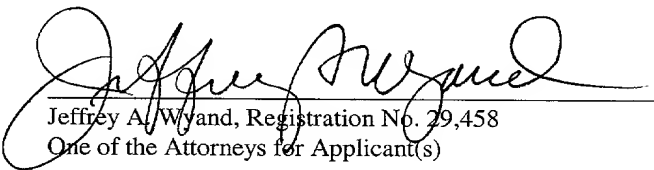
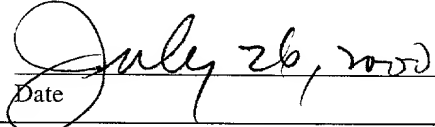
YASUDA ET AL.

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 USC 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 USC 371.
3. ☒ This is an express request to begin national examination procedures (35 USC 371(f)).
4. ☒ The US has been elected by the expiration of 19 months from the priority date (PCT Article 31).
5. ☒ A copy of the International Application as filed (35 USC 371(c)(2))
 - a. ☐ is attached hereto (required only if not communicated by the International Bureau).
 - b. ☒ has been communicated by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ An English language translation of the International Application as filed (35 USC 371(c)(2)).
7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 USC 371(c)(3))
 - a. ☐ are attached hereto (required only if not communicated by the International Bureau).
 - b. ☐ have been communicated by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☐ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 USC 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 USC 371(c)(4)).
10. ☐ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 USC 371(c)(5)).
11. Nucleotide and/or Amino Acid Sequence Submission
 - a. ☐ Computer Readable Form (CRF)
 - b. Specification Sequence Listing on:
 - i. ☐ CD-ROM or CD-R (2 copies); or
 - ii. ☐ Paper Copy
 - c. ☐ Statement verifying identity of above copies

Items 12 to 19 below concern other document(s) or information included:

12. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
 - ☒ Form PTO-1449
 - ☒ Copies of Listed Documents
13. ☐ An assignment for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
14. ☒ A **FIRST** preliminary amendment.
 - ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
15. ☐ A substitute specification.
16. ☐ A change of power of attorney and/or address letter.
17. ☒ Application Data Sheet Under 37 CFR 1.76
18. ☒ Return Receipt Postcard
19. ☒ Request for approval of Drawing Amendment

U.S. APPLICATION NO. 09/890103		INTERNATIONAL APPLICATION NO. PCT/JP99/07230		ATTORNEY DOCKET NO. 401312	
20. <input checked="" type="checkbox"/> The following fees are submitted:				CALCULATIONS	PTO USE ONLY
Basic National Fee (37 CFR 1.492(a)(1)-(5)): Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO..... \$1,000.00 International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO..... \$ 860.00 International preliminary examination fee (37 CFR 1.482) paid to USPTO, but international search fee (37 CFR 1.445(a)(2)) paid to USPTO..... \$ 710.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4)..... \$ 690.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1) to (4)..... \$ 100.00					
ENTER APPROPRIATE BASIC FEE AMOUNT=				\$860.00	
Surcharge of \$130.00 for furnishing the National fee or oath or declaration later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date				\$	
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total Claims	13 -20=		x \$ 18.00	\$	
Independent Claims	2 - 3 =		x \$ 80.00	\$	
<input type="checkbox"/> Multiple Dependent Claim(s) (if applicable)			+\$270.00	\$	
TOTAL OF ABOVE CALCULATIONS=				\$860.00	
<input type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.				\$	
SUBTOTAL=				\$	
Processing fee of \$130.00 for furnishing English Translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date.				\$	
TOTAL NATIONAL FEE=				\$	
Fee for recording the enclosed assignment. The assignment must be accompanied by an appropriate cover sheet. \$40.00 per property				+	\$
TOTAL FEE ENCLOSED=				\$860.00	
				Amount to be:	
				refunded	\$
				charged:	\$
a. <input checked="" type="checkbox"/> A check in the amount of \$860.00 to cover the above fee is enclosed. b. <input type="checkbox"/> Please charge Deposit Account No. 12-1216 in the amount of \$ to cover the above fees. A duplicate copy of this sheet is enclosed. c. <input checked="" type="checkbox"/> The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 12-1216. A duplicate copy of this sheet is enclosed.					
NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.					
SEND ALL CORRESPONDENCE TO:					
 23548 PATENT TRADEMARK OFFICE		 Jeffrey A. Wyand, Registration No. 29,458 One of the Attorneys for Applicant(s)			
		 Date			

PATENT
Attorney Docket No. 401312

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

YASUDA et al.

Application No.: Unassigned

Art Unit: Unassigned

Filed: July 26, 2001

Examiner: Unassigned

For: SENSOR ELEMENT AND
METHOD OF
FABRICATING
THEREOF

PRELIMINARY AMENDMENT

Commissioner for Patents
Washington, D. C. 20231

Dear Sir:

Prior to the examination of the above-identified patent application, please enter the following amendments and consider the following remarks.

IN THE DRAWINGS

The Examiner is requested to approve the changes to Figures 3A and 4A as indicated in the attached Request for Approval of Drawing Amendment.

09890103-092501

IN THE SPECIFICATION

Replace the paragraph beginning at page 1, line 5, with:

The present invention relates to a sensor element, particularly to a sensor such as a magnetoresistance sensor, an air flow sensor, an acceleration sensor, a pressure sensor, a yaw rate sensor, or an image sensor having a constant area sensor face.

Replace the paragraph beginning at page 1, line 11, with:

Conventionally, an acceleration sensor, a yaw rate sensor, a pressure sensor, an air flow sensor, and a magnetoresistance sensor are used as sensor elements for controlling running of a vehicle. Among them, each of the acceleration sensor, the yaw rate sensor, and the pressure sensor includes a flat pivotally moving electrode (sensing portion) responding to impact or acceleration, and detecting a change in electric capacitance between the electrode and an opposed electrode fixedly arranged proximate the moving electrode. Further, various metal materials are used for the planar electrode constituting the sensing portion, for example, as described in Japanese Patent Laid-Open No. Hei. 5-183145, Japanese Patent Laid-Open No. Hei. 5-283712, or Japanese Patent Laid-Open No. Hei. 6-194382, a surface thereof is covered and protected by a silicon nitride film or a silicon oxide film, and these inorganic thin films are formed by sputtering, CVD, or another vapor deposition process.

After the paragraph beginning at page 4, line 6, insert as a heading:

Summary of the Invention

Replace the paragraph beginning at page 6, line 16, with:

Figs. 1A-1G are sectional views for explaining an example of a structure of a magnetoresistance sensor according to the invention and a method of fabricating thereof.

Replace the paragraph beginning at page 6, line 19, with:

Figs. 2A-2D are sectional views for explaining another example of a structure of a magnetoresistance sensor according to the invention and a method of fabricating thereof.

Replace the paragraph beginning at page 6, line 22, with:

Figs. 3A and 3B are views for explaining a structure of an air flow sensor of Embodiment 1 according to the invention in which Fig. 3A is a plane view and Fig. 3B is a sectional -25 view taken along a line IIIB-IIIB of Fig. 3A..

Replace the paragraph beginning at page 7, line 1, with:

Figs. 4A and 4B are views for explaining a structure of an acceleration sensor of Embodiment 3 according to the invention in which Fig. 4A is a plane view and Fig. 4B is a sectional view taken along a line IVB-IVB of Fig. 4A.

Replace the paragraph beginning at page 12, line 2, with:

Fig. 1A through Fig. 1G are sectional views for explaining an example of a method of fabricating the magnetoresistance sensor according to the invention. First, above the sensor main body 1, there is coated varnish prepared by dissolving silicone polymer shown by the above-described general formula (1) and/or general formula (2) in a solvent of alcoholic species, ketone species, ether species, halogen species, ester species, benzene species, alkoxybenzene species, or cyclic ketone species by a film thickness of 10 nm through 50 μ m, a heat treatment is carried out at 100°C through 250°C above a hot plate, and the silicone resin film 2 is formed above the sensor main body 1 (Fig. 1A).

Replace the paragraph beginning at page 12, line 14, with:

Next, there is applied an i-line positive resist 3 having a film thickness of 100 nm through 20 pm on the surface of the silicone resin film 2 (Fig. 1B), ultraviolet light (i-line) is irradiated through a mask 4 having a contact hole pattern for exposing the bonding pad 1e or dicing lines (not illustrated) of the sensor main body 1, and the i-line positive resist 3 of the contact hole portion is exposed (Fig. 1C).

Replace the paragraph beginning at page 12, line 22, with:

Next, developing processing is carried out after carrying out a baking operation after exposure to thereby provide a pattern of the i-line positive resist 3 having a desired pattern (Fig. 1D).

Replace the paragraph beginning at page 13, line 1, with:

With the pattern of the i-line positive resist 3 as a mask, contact holes are provided by developing the silicone resin film 2. The developing processing is carried out by carrying out dipping development or spinning development by a developer exclusive for the silicone resin film and thereafter cleaning by a rinse solution exclusive for the silicone resin film (Fig. 1E).

Replace the paragraph beginning at page 13, line 8, with:

Next, after removing the passivation film 1f by a dry etching process (Fig. 1F), the i-line positive resist 3 above the silicone resin film 2 is removed in a wet state or removed in a dry state by using a reactive ion etching apparatus, an ion beam etching apparatus, or an ashing apparatus, and by using an oven or a hot plate, postbaking is carried out at 200°C through 450°C to thereby cure the silicone resin film 2. Thereby, there is provided the magnetoresistance sensor covered with the silicone resin film 2, a predetermined portion of which is opened (Fig. 1G).

Replace the paragraph beginning at page 18, line 12, with:

Fig. 2D is a sectional view explaining another example of a magnetoresistance sensor according to the invention. Although the constitution of the sensor main body 1 is the same as that of Fig. 1G, above the sensor main body 1, there is formed a silicone resin film 13 which is photocured to cover at least the sensing portion.

Replace the paragraph beginning at page 18, line 22, with:

Figs. 2A through 2D are sectional views for explaining another example of a method of fabricating a magnetoresistance sensor according to the invention. The method of fabricating the magnetoresistance sensor differs from the above-described method in that there is used a compound prepared by dissolving a polymer having a photocrosslinking characteristic in a solvent and adding a photocrosslinking agent or a photopolymerization agent thereto. The silicone resin film is cured by irradiating and exposing through a mask 5 having a desired pattern, removing the silicone resin film at a portion which is not irradiated with light by developing, and postbaking at 100°C through 250°C (Figs. 2B and C). When the passivation film 1f is removed by the dry etching process, there is provided the magnetoresistance sensor covered with the silicone resin film 13 which is cured optically and a predetermined portion of which is opened (Fig. 2D).

Replace the paragraph beginning at page 20, line 10, with:

Figs. 3A and 3B illustrate views for explaining a structure of an air flow sensor of Embodiment 1 according to the invention in which Fig. 3A is a plan view and Fig. 3B is a sectional view taken along a line IIIB-IIIB of Fig. 3A.

Replace the paragraph beginning at page 24, line 5, with:

Fig. 1G is a sectional view for explaining a structure of a magnetoresistance sensor of Embodiment 2 according to the invention. The passivation film 1f of the sensor main body 1 is a silicon nitride film having a film thickness of about 800 nm formed by a sputtering apparatus and the silicone resin film 2 was formed on the surface of the passivation film 1f by the following method.

Replace the paragraph beginning at page 25, line 18, with:

Figs. 4A and 4B are views for explaining a structure of an acceleration sensor of Embodiment 3 according to the invention in which Fig. 4A is a plan view and Fig. 4B is a sectional view taken along a line IVB-IVB of Fig. 4A.

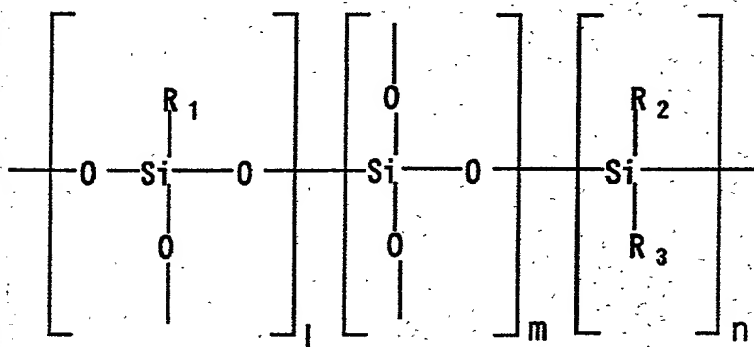
Replace the paragraph beginning at page 28, line 22, with:

When operation of the acceleration sensor covered with the silicone resin film 45 was confirmed, in accordance with acceleration, the sensing portion 43 was displaced in a direction in which the distance between the sensing portion 43 and the opposed electrode 44 is changed (arrow direction of Fig. 4A). The change in the interval between the side face of the sensing portion 43 and the side face of the opposed electrode 44 was detected as a change in the capacitance and it was verified that there was provided a sensitivity of a sufficiently practical level.

IN THE CLAIMS

Replace the indicated claims with:

1. (Amended) A sensor element comprising:
a sensor substrate; and
a flat sensing portion supported by the sensor substrate; wherein the surface of the flat sensing portion is covered with a silicone resin film.
2. (Amended) The sensor element according to Claim 1 wherein the silicone resin film is a film of a cured silicone polymer.
3. (Amended) The sensor element according to Claim 2, wherein the silicone polymer is represented by the following general formula (1)



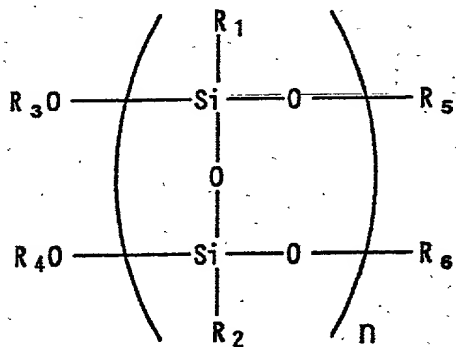
wherein

R1, R2, and R3, which may be the same or different, and are selected from the group consisting of an aryl, hydrogen, an aliphatic alkyl, a hydroxyl, a trialkylsilyl, and a functional group having an unsaturated bond,

l, m, and n are integers and at least 0, and

the silicone polymer has a weight average molecular weight of not less than 1000.

4. (Amended) The sensor element according to Claim 2 wherein the silicone polymer is represented by the following general formula (2)



wherein

R1 and R2, which may be the same or different, and are selected from the group consisting of an aryl, hydrogen, an aliphatic alkyl, and a functional group having an unsaturated bond,

R3, R4, R5, and R6, which may be the same or different, and are selected from the group consisting of hydrogen, an aryl, an aliphatic alkyl, a trialkylsilyl, and a functional group having an unsaturated bond,

n is an integers, and

the silicone polymer has a weight average molecular weight of not less than 1000.

5. (Amended) The sensor element according to Claim 3 wherein the silicone polymer is a photocuring polymer.

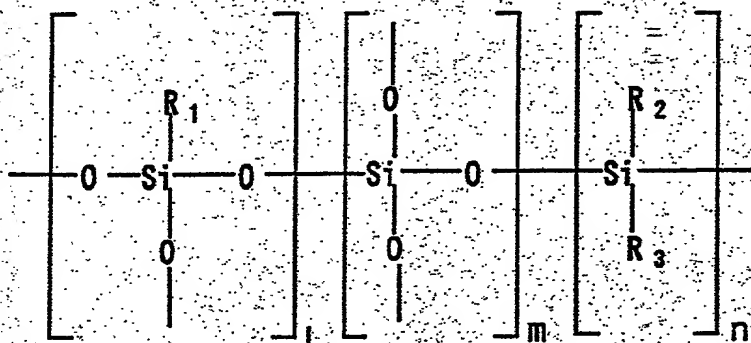
6. (Amended) The sensor element according to Claim 4 wherein the silicone polymer is a photocuring polymer.

7. (Amended) The sensor element according to Claim 1 wherein the sensor element is selected from a magnetoresistance sensor, an air flow sensor, an acceleration sensor, a pressure sensor, a yaw rate sensor, and an image sensor.

8. (Amended) A method of fabricating a sensor element comprising coating a flat sensing portion supported by a sensor substrate with a solution of a silicone polymer; and

heating and curing the solution to form a silicone resin film on the flat sensing portion.

9. (Amended) The method of fabricating a sensor element according to Claim 8 wherein the silicone polymer is represented by the following general formula (1)



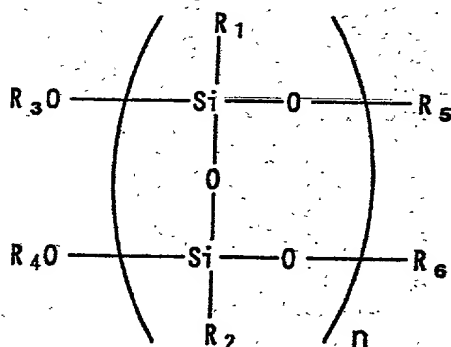
wherein

R1, R2, and R3, which may be the same or different, and are selected from the group consisting of an aryl, hydrogen, an aliphatic alkyl, a hydroxyl, a trialkylsilyl, and a functional group having an unsaturated bond,

l, m, and n are integers and at least 0, and

the silicone polymer has a weight average molecular weight of not less than 1000.

10. (Amended) The method of fabricating a sensor element according to Claim 8 wherein the silicone polymer is represented by the following general formula (2)



wherein

R1 and R2, which may be the same or different, and are selected from the group consisting of an aryl, hydrogen, an aliphatic alkyl, and a functional group having an unsaturated bond,

R3, R4, R5, and R6, which may be the same or different, and are selected from the group consisting of hydrogen, an aryl, an aliphatic alkyl, a trialkylsilyl, and a functional group having an unsaturated bond,

n is an integers, and

the silicone polymer has a weight average molecular weight of not less than 1000.

11. (Amended) The method of fabricating a sensor element according to Claim 9 including curing the silicone polymer with light.

12. (Amended) The method of fabricating a sensor element according to Claim 10 including curing the silicone polymer with light.

13. (Amended) The method of fabricating a sensor element according to Claim 8 including heating and curing the solution at a temperature of from 100°C to 250°C.

In re Application of:
Application No. Unassigned

IN THE ABSTRACT

Replace the abstract with:

Abstract

A sensor element having a sensor substrate and a flat sensor portion supported by the sensor substrate in which the surface of the flat sensing portion is covered with a silicone resin film. The silicone resin film is excellent in step coverage of the flat sensing portion, applies low stress to the sensing portion, can be formed at low temperature, and can prevent the sensing portion from being adversely affected in the fabrication process.

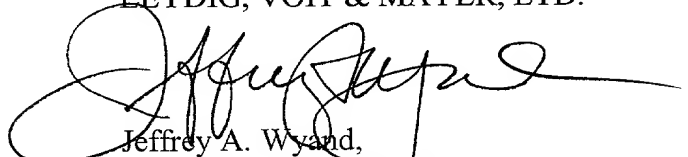
In re Application of:
Application No. Unassigned

REMARKS

The foregoing amendments are made to correct minor translational errors and to meet United States requirements as to form. No new matter is added.

Respectfully submitted,

LEYDIG, VOIT & MAYER, LTD.



Jeffrey A. Wyand,
Registration No. 29,458

Suite 300
700 Thirteenth Street, N. W.
Washington, D. C. 20005
Telephone: (202) 737-6770
Facsimile: (202) 737-6776
Date: July 26, 2001
JAW:cmcg

PATENT
Attorney Docket No. 401312

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

YASUDA et al.

Application No.: Unassigned Art Unit: Unassigned

Filed: July 25, 2001 Examiner: Unassigned

For: SENSOR ELEMENT
 AND METHOD OF
 FABRICATING
 THEREOF

**SPECIFICATION, CLAIMS AND
ABSTRACT AS PRELIMINARILY AMENDED**

Amendment to the paragraph beginning at page 1, line 5:

The present invention relates to a sensor element, particularly to a sensor such as a magnetoresistance sensor, an air flow sensor, an acceleration sensor, a pressure sensor, a yaw rate sensor, or an image sensor having a constant area of sensor face.

Amendment to the paragraph beginning at page 1, line 11:

Conventionally, ~~there are used~~ an acceleration sensor, a yaw rate sensor, a pressure sensor, an air flow sensor, and a magnetoresistance sensor are used as sensor elements for controlling running of a vehicle. Among them, each of the acceleration sensor, the yaw rate sensor ~~or, and~~ the pressure sensor ~~each is provided with~~ includes a flat pivotally moving electrode (sensing portion) ~~in correspondence with~~ responding to impact or acceleration, and ~~is constituted to be capable of~~ detecting a change in electric capacitance between the electrode and an opposed electrode fixedly arranged ~~to be~~ proximate thereto for ~~detecting a change in impact or acceleration based on the change in~~ the electric capacitance moving electrode. Further, ~~there are used~~ various metal materials are used for the planar electrode constituting the sensing portion, for example, as

09890103-092501

In re Application of:
Application No. Unassigned

described in Japanese Patent Laid-Open No. ~~183145/1993~~ Hei. 5-183145, Japanese Patent Laid-Open No. ~~283712/1993~~ Hei. 5-283712, or Japanese Patent Laid-Open No. ~~194382/1994~~ Hei. 6-194382, a surface thereof is covered and protected by a silicon nitride film or a silicon oxide film, and these inorganic thin films are formed by ~~a sputtering process, a CVD process, or another~~ vapor deposition process.

After the paragraph beginning at page 4, line 6, insert as a heading:

Summary of the Invention

Amendment to the paragraph beginning at page 6, line 16:

~~Fig. 1 illustrates~~ Figs. 1A-1G are sectional views for explaining an example of a structure of a magnetoresistance sensor according to the invention and a method of fabricating thereof.

Amendment to the paragraph beginning at page 6, line 19:

~~Fig. 2 illustrates~~ Figs. 2A-2D are sectional views for explaining ~~other another~~ example of a structure of a magnetoresistance sensor according to the invention and a method of fabricating thereof.

Amendment to the paragraph beginning at page 6, line 22:

~~Fig. 3 illustrates~~ Figs. 3A and 3B are views for explaining a structure of an air flow sensor of Embodiment 1 according to the invention in which Fig. 3 ~~(a)~~ A is a plane view and Fig. 3 ~~(b)~~ B is a sectional -25 view taken along a line ~~A-A~~ IIIB-IIIB of Fig. 3A..

Amendment to the paragraph beginning at page 7, line 1:

~~Fig. 4 illustrates~~ Figs. 4A and 4B are views for explaining a structure of an
acceleration sensor of Embodiment 3 according to the invention in which Fig. 4~~(a)~~A is a
plane view and Fig. 4~~(b)~~B is a sectional view taken along a line ~~B-B~~ IVB-IVB of Fig.
4A.

Amendment to the paragraph beginning at page 12, line 2:

Fig. 1~~(a)~~A through Fig. 1~~(g)~~G are sectional views for explaining an example of a
method of fabricating the magnetoresistance sensor according to the invention. First,
above the sensor main body 1, there is coated varnish prepared by dissolving silicone
polymer shown by the above-described general formula (1) and/or general formula (2) in
a solvent of alcoholic species, ketone species, ether species, halogen species, ester
species, benzene species, alkoxybenzene species, or cyclic ~~keton~~ ketone species by a film
thickness of 10 nm through 50 μ m, a heat treatment is carried out at 100°C through 250°C
above a hot plate, and the silicone resin film 2 is formed above the sensor main body 1
(Fig. 1~~(a)~~A).

Amendment to the paragraph beginning at page 12, line 14:

Next, there is ~~coated~~ applied an i-line positive resist 3 having a film thickness of
100 nm through 20 μ m on the surface of the silicone resin film 2 (Fig. 1~~(b)~~B), ultraviolet
~~ray light~~ (i-line) is irradiated ~~from thereabove by using~~ through a mask 4 having a contact
hole pattern for exposing the bonding pad 1e or dicing lines (not illustrated) of the sensor
main body 1, and the i-line positive resist 3 of the contact hole portion is exposed (Fig.
1~~(c)~~C).

Amendment to the paragraph beginning at page 12, line 22:

Next, ~~a~~ developing processing is carried out after carrying out a baking operation after exposure to thereby provide a pattern of the i-line positive resist 3 having a desired pattern (Fig. 1~~(d)~~D).

Amendment to the paragraph beginning at page 13, line 1:

With the pattern of the i-line positive resist 3 as a mask, contact holes are provided by developing the silicone resin film 2. The developing processing is carried out by carrying out dipping development or spinning development by a developer exclusive for the silicone resin film and thereafter cleaning by a rinse solution exclusive for the silicone resin film (Fig. 1~~(e)~~E).

Amendment to the paragraph beginning at page 13, line 8:

Next, after removing the passivation film 1f by a dry etching process (Fig. 1~~(f)~~F), the i-line positive resist 3 above the silicone resin film 2 is removed in a wet state or removed in a dry state by using a reactive ion etching apparatus, an ion beam etching apparatus, or an ashing apparatus, and by using an oven or a hot plate, postbaking is carried out at 200°C through 450°C to thereby cure the silicone resin film 2. Thereby, there is provided the ~~magnetoresistance~~ magnetoresistance sensor covered with the silicone resin film 2, a predetermined portion of which is opened (Fig. 1~~(g)~~G).

Amendment to the paragraph beginning at page 18, line 12:

Fig. 2~~(d)~~D is a sectional view explaining ~~other~~ another example of a magnetoresistance sensor according to the invention. Although the constitution of the sensor main body 1 is the same as that of Fig. 1G, above the sensor main body 1, there is formed a silicone resin film 13 which is photocured to cover at least the sensing portion.

Amendment to the paragraph beginning at page 18, line 22:

Figs. 2(a)A through 2(d)D are sectional views for explaining ~~other~~ another example of a method of fabricating a magnetoresistance sensor according to the invention. The method of fabricating the magnetoresistance sensor differs from the above-described method in that there is used a compound prepared by dissolving a polymer having a photocrosslinking performance characteristic in a solvent and adding a photocrosslinking agent or a photopolymerization agent thereto. The silicone resin film is cured by irradiating and exposing ~~from above by using~~ through a mask 5 having a desired pattern, removing the silicone resin film at a portion which is not irradiated with light by ~~a developing processing, and carrying out~~ postbaking at 100°C through 250°C (Figs. 2(b)B and 2(c)C). When the passivation film 1f is removed by the dry etching process, there is provided the magnetoresistance sensor covered with the silicone resin film 13 which is cured optically and a predetermined portion of which is opened (Fig. 2(d)D).

Amendment to the paragraph beginning at page 20, line 10:

~~Fig. 3 illustrates~~ Figs. 3A and 3B illustrate views for explaining a structure of an air flow sensor of Embodiment 1 according to the invention in which Fig. 3(a)A is a plane plan view and Fig. 3(b)B is a sectional view taken along a line ~~A-A~~ IIIB-IIIB of Fig. 3A.

Amendment to the paragraph beginning at page 24, line 5:

Fig. ~~2(g)~~ 1G is a sectional view for explaining a structure of a magnetoresistance sensor of Embodiment 2 according to the invention. The passivation film 1f of the sensor main body 1 is a silicon nitride film having a film thickness of about 800 nm formed by a sputtering apparatus and the silicone resin film 2 was formed on the surface of the passivation film 1f by the following method.

Amendment to the paragraph beginning at page 25, line 18:

~~Fig. 4 illustrates~~ Figs. 4A and 4B are views for explaining a structure of an
acceleration sensor of Embodiment 3 according to the invention in which Fig. 4~~(a)~~A is a
~~plane~~ plan view and Fig. 4~~(b)~~B is a sectional view taken along a line ~~B-B~~ IVB-IVB of
Fig. 4A.

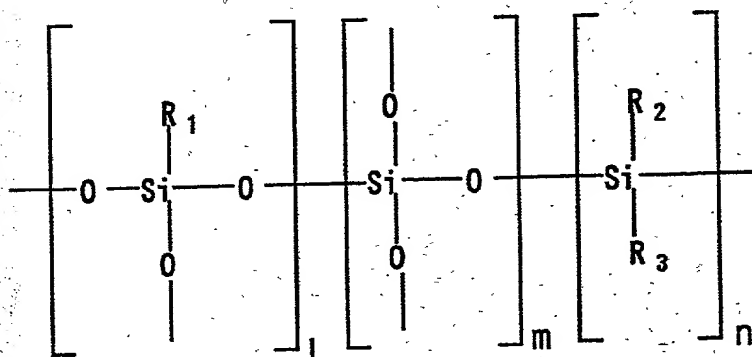
Amendment to the paragraph beginning at page 28, line 22:

When operation of the acceleration sensor covered with the silicone resin film 45
was confirmed, in accordance with acceleration, the sensing portion 43 was displaced in a
direction in which the distance between the sensing portion 43 and the opposed electrode
44 is changed (arrow ~~mark~~ direction of Fig. 4~~(a)~~A). The change in the interval between
the side face of the sensing portion 43 and the side face of the opposed electrode 44 was
detected as a change in the ~~electric~~ capacitance and it was verified that there was provided
a sensitivity of a sufficiently practical level.

Amendments to the existing claims:

1. (Amended) A sensor element comprising:
a sensor substrate; and
a flat sensing portion supported by the sensor substrate; wherein the surface of the
flat sensing portion is covered with a silicone resin film.
2. (Amended) The sensor element according to Claim 1; wherein the silicone
resin film is a film of a cured silicone polymer.

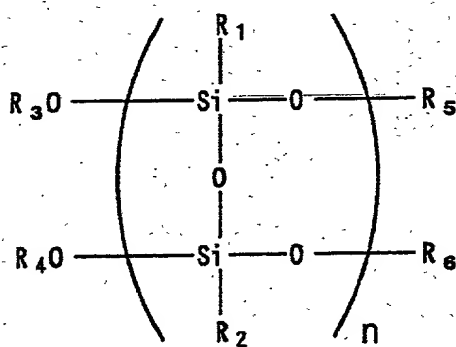
3. (Amended) The sensor element according to Claim 2, wherein the silicone polymer is represented by the following general formula (1):



wherein

R₁, R₂, and R₃, which may be the same or different, ~~each is and~~ are selected from the group consisting of an aryl group, hydrogen atom, an aliphatic alkyl group, a hydroxyl group, a trialkylsilyl group or, and a functional group having an unsaturated bond; and 1, m, and n ~~each is are~~ integers of and at least 0 or more, and the silicone polymer has a weight average molecular weight of not less than 1000.

4. (Amended) The sensor element according to Claim 2, wherein the silicone polymer is represented by the following general formula (2):



wherein

R₁ and R₂, which may be the same or different, ~~each is and~~ are selected from the group consisting of an aryl group, hydrogen atom, an aliphatic alkyl group or, and a functional group having an unsaturated bond. ~~Notation,~~

R3, R4, R5, and R6, which may be the same or different, ~~each is and are selected~~
from the group consisting of hydrogen-atom, an aryl-group, an aliphatic alkyl-group, a
trialkylsilyl-group or, and a functional group having an unsaturated bond;

n is an integers; and

the silicone polymer has a weight average molecular weight of not less than 1000.

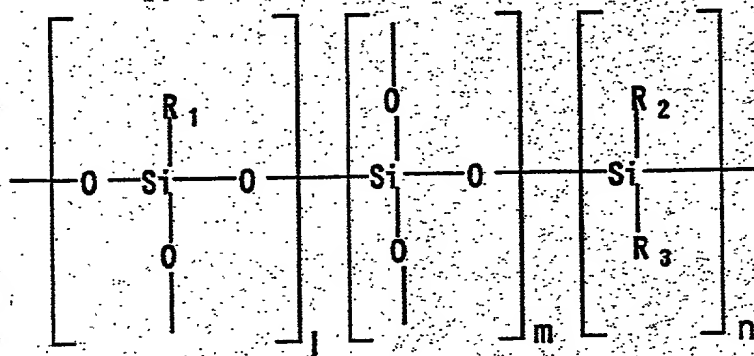
5. (Amended) The sensor element according to Claim 3; wherein the silicone
polymer is a photocuring polymer.

6. (Amended) The sensor element according to Claim 4; wherein the silicone
polymer is a photocuring polymer.

7. (Amended) The sensor element according to Claim 1; wherein the sensor
element is selected from a magnetoresistance sensor, an air flow sensor, an acceleration
sensor, a pressure sensor, a yaw rate sensor, and an image sensor.

8. (Amended) A method of fabricating a sensor element; comprising
~~a step of coating a solution of a silicone polymer to a flat sensing portion supported~~
by a sensor substrate with a solution of a silicone polymer; and
~~a step of heating and curing thereof, the solution to coat the sensing portion with~~
form a silicone resin film on the flat sensing portion.

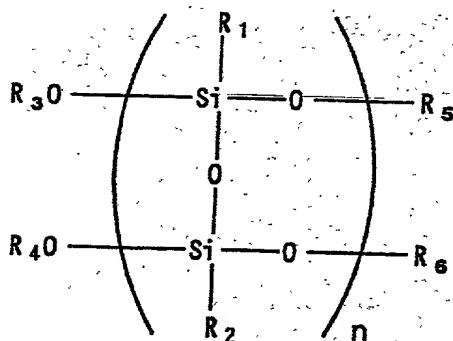
9. (Amended) The method of fabricating a sensor element according to Claim 8;
wherein the silicone polymer is represented by the following general formula (1);



wherein

R1, R2, and R3, which may be the same or different, ~~each is and are selected from~~
~~the group consisting of an aryl-group, hydrogen-atom, an aliphatic alkyl-group, a hydroxyl~~
~~group, a trialkylsilyl-group or, and a functional group having an unsaturated bond;~~ and
1, m, and n ~~each is are integers of and at least 0 or more;~~ and
the silicone polymer has a weight average molecular weight of not less than 1000.

10. (Amended) The method of fabricating a sensor element according to Claim 8
wherein the silicone polymer is represented by the following general formula (2);



wherein

R1 and R2, which may be the same or different, ~~each is and are selected from the~~
~~group consisting of an aryl-group, hydrogen-atom, an aliphatic alkyl-group or, and a~~
~~functional group having an unsaturated bond.~~ Notation,

R3, R4, R5, and R6, which may be the same or different, ~~each is and are selected~~
~~from the group consisting of hydrogen-atom, an aryl-group, an aliphatic alkyl-group, a~~
~~trialkylsilyl-group or, and a functional group having an unsaturated bond;~~

n is an integers; and

the silicone polymer has a weight average molecular weight of not less than 1000.

11. (Amended) The method of fabricating a sensor element according to Claim 9;
~~wherein including curing the silicone polymer is a photocuring polymer with light.~~

In re Application of:
Application No. Unassigned

12. (Amended) The method of fabricating a sensor element according to Claim 10:
~~wherein including curing the silicone polymer is a photocuring polymer with light.~~

13. (Amended) The method of fabricating a sensor element according to Claim 8:
~~wherein the step of including heating and curing is carried out the solution at a~~
temperature of from 100°C to 250°C.

Amendment to the abstract:

Abstract

~~The invention provides a~~ A sensor element having a sensor substrate and a flat
sensor portion supported by the sensor substrate in which the surface of the flat sensing
portion is covered with a silicone resin film. The silicone resin film is excellent in step
coverage of the flat sensing portion, ~~having~~ applies low stress ~~applied~~ to the sensing
portion, can be formed at low temperature, and can prevent the sensing portion from
~~being effected with adverse influence even~~ adversely affected in the fabrication ~~steps~~
process.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

YASUDA et al.

Application No.: Unassigned

Art Unit: Unassigned

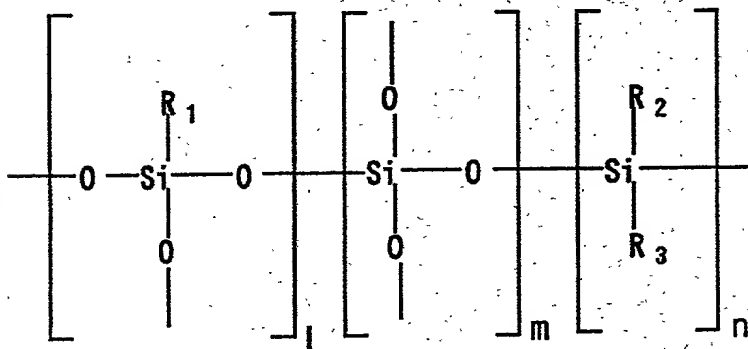
Filed: July 25, 2001

Examiner: Unassigned

For: SENSOR ELEMENT
AND METHOD OF
FABRICATING
THEREOF

CLAIMS PENDING AFTER PRELIMINARY AMENDMENT

1. (Amended) A sensor element comprising:
a sensor substrate; and
a flat sensing portion supported by the sensor substrate; wherein the surface of the flat sensing portion is covered with a silicone resin film.
2. (Amended) The sensor element according to Claim 1 wherein the silicone resin film is a film of a cured silicone polymer.
3. (Amended) The sensor element according to Claim 2, wherein the silicone polymer is represented by the following general formula (1)



the silicone polymer has a weight average molecular weight of not less than 1000.

$$\left(\begin{array}{c} R_1 \\ | \\ Si - O - Si - R_5 \\ | \\ O \\ | \\ Si - O - Si - R_6 \\ | \\ R_2 \end{array} \right)_n$$

Chemical structure of a siloxane unit in a polymer chain, showing two silicon atoms (Si) connected by an oxygen atom (O). The silicon atoms are also bonded to oxygen atoms (O) and various R groups (R1, R2, R3, R4, R5, R6). The structure is enclosed in large parentheses with a subscript n.

the silicone polymer has a weight average molecular weight of not less than 1000.

B2

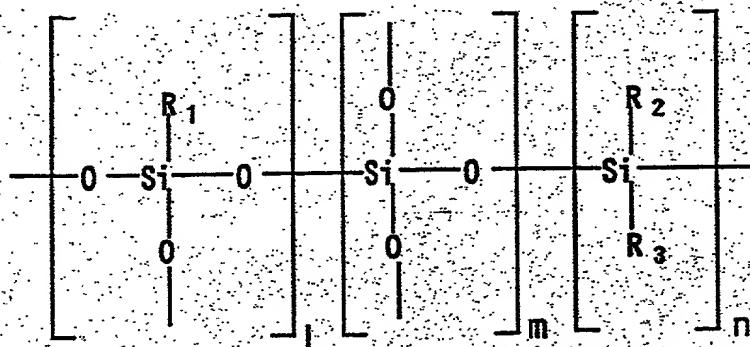
6. (Amended) The sensor element according to Claim 4 wherein the silicone polymer is a photocuring polymer.

7. (Amended) The sensor element according to Claim 1 wherein the sensor element is selected from a magnetoresistance sensor, an air flow sensor, an acceleration sensor, a pressure sensor, a yaw rate sensor, and an image sensor.

8. (Amended) A method of fabricating a sensor element comprising coating a flat sensing portion supported by a sensor substrate with a solution of a silicone polymer; and

heating and curing the solution to form a silicone resin film on the flat sensing

9. (Amended) The method of fabricating a sensor element according to Claim 8 wherein the silicone polymer is represented by the following general formula (1)



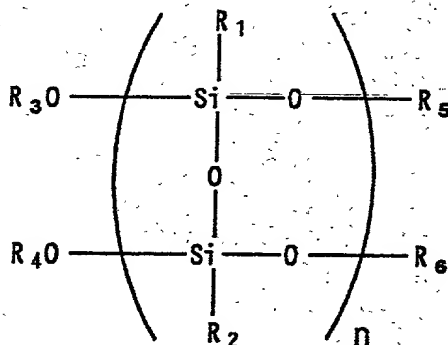
wherein

R1, R2, and R3, which may be the same or different, and are selected from the group consisting of an aryl, hydrogen, an aliphatic alkyl, a hydroxyl, a trialkylsilyl, and a functional group having an unsaturated bond,

1, m, and n are integers and at least 0, and

the silicone polymer has a weight average molecular weight of not less than 1000.

wherein the silicone polymer is represented by the following general formula (2)



wherein

R1 and R2, which may be the same or different, and are selected from the group consisting of an aryl, hydrogen, an aliphatic alkyl, and a functional group having an unsaturated bond,

R3, R4, R5, and R6, which may be the same or different, and are selected from the group consisting of hydrogen, an aryl, an aliphatic alkyl, a trialkylsilyl, and a functional group having an unsaturated bond,

n is an integers, and

the silicone polymer has a weight average molecular weight of not less than 1000.

11. (Amended) The method of fabricating a sensor element according to Claim 9 including curing the silicone polymer with light.

12. (Amended) The method of fabricating a sensor element according to Claim 10 including curing the silicone polymer with light.

13. (Amended) The method of fabricating a sensor element according to Claim 8 including heating and curing the solution at a temperature of from 100°C to 250°C.

PATENT
Attorney Docket No. 401312

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

YASUDA et al.

Application No.: Unassigned

Art Unit: Unassigned

Filed: July 26, 2001

Examiner: Unassigned

For: SENSOR ELEMENT AND
METHOD OF
FABRICATING
THEREOF

REQUEST FOR APPROVAL OF DRAWING AMENDMENT

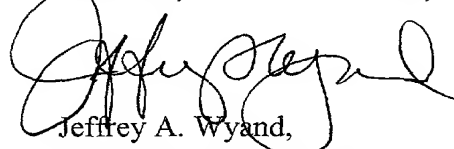
Commissioner for Patents
Washington, D. C. 20231

Dear Sir:

The Examiner is requested to approve the changes indicated in red on the attached copies of Figures 3A and 4A

Respectfully submitted,

LEYDIG, VOIT & MAYER, LTD.



Jeffrey A. Wyand,
Registration No. 29,458

Suite 300
700 Thirteenth Street, N. W.
Washington, D. C. 20005
Telephone: (202) 737-6770
Facsimile: (202) 737-6776
Date: July 26, 2001
JAW:cmcg

FIG.3A

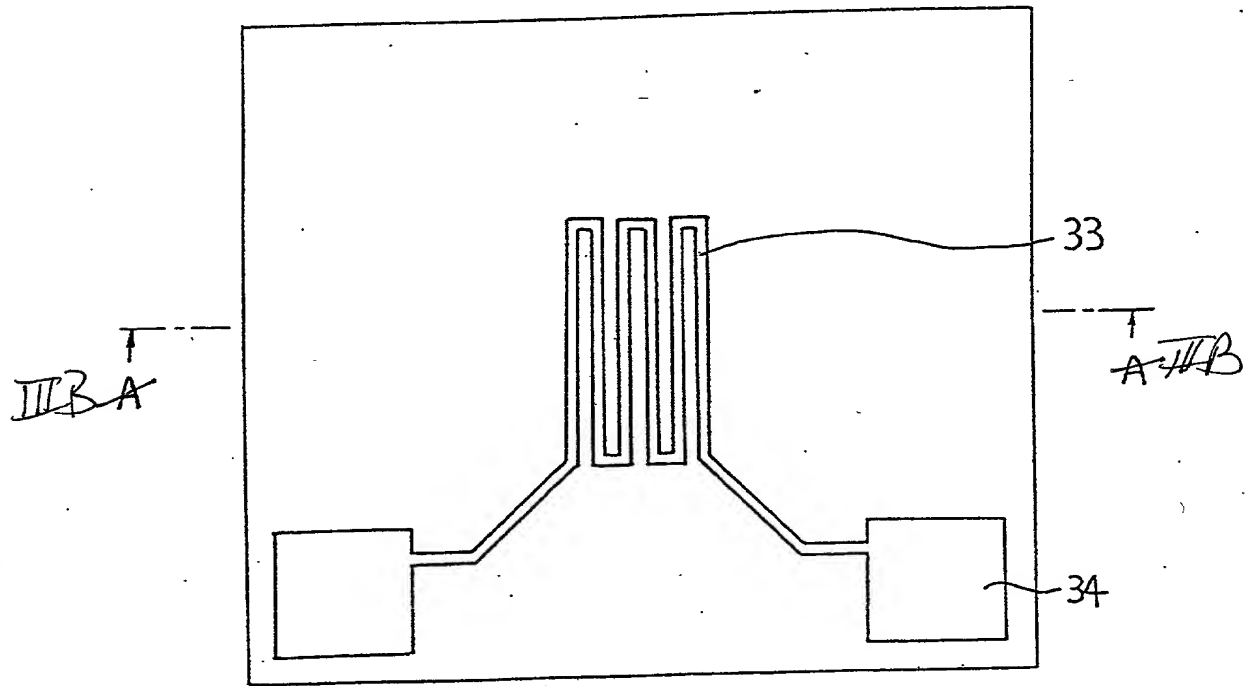


FIG.3B

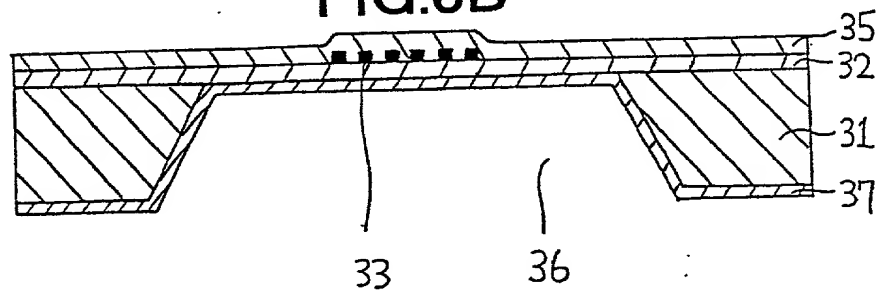


FIG.4A

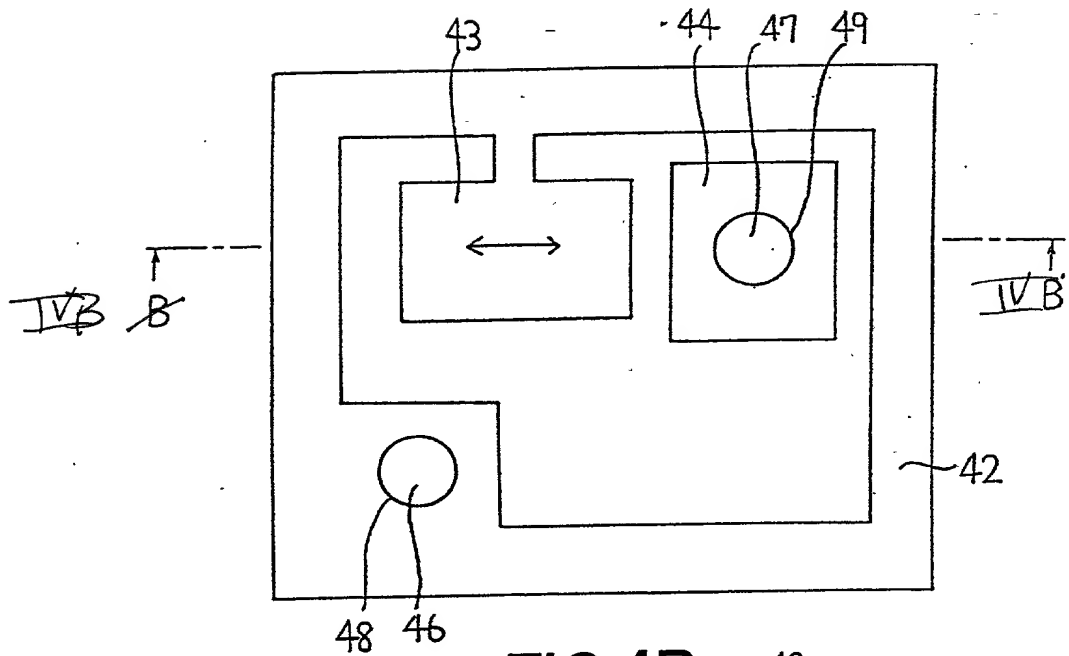
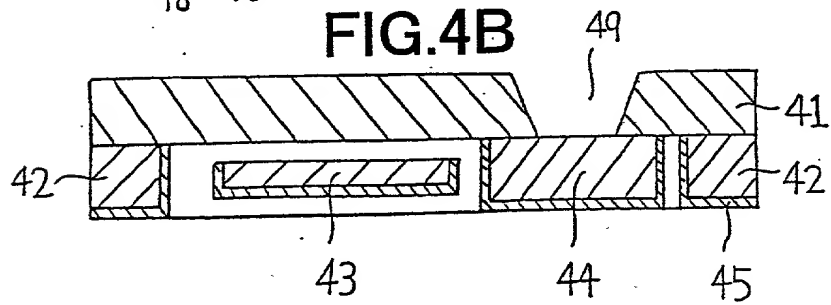


FIG.4B



DESCRIPTION

SENSOR ELEMENT AND METHOD OF FABRICATING THEREOF

Technical Field

5 The present invention relates to a sensor element, particularly to a sensor such as a magnetoresistance sensor, an air flow sensor, an acceleration sensor, a pressure sensor, a yaw rate sensor or an image sensor having a constant area of sensor face.

10 Background Art

Conventionally, there are used an acceleration sensor, a yaw rate sensor, a pressure sensor, an air flow sensor and a magnetoresistance sensor as sensor elements for controlling running of a vehicle. Among them, the acceleration sensor,
15 the yaw rate sensor or the pressure sensor each is provided with a flat pivotally moving electrode (sensing portion) in correspondence with impact or acceleration, and is constituted to be capable of detecting a change in electric capacitance between the electrode and an opposed electrode fixedly arranged
20 to be proximate thereto for detecting a change in impact or acceleration based on the change in the electric capacitance. Further, there are used various metal materials for the planar electrode constituting the sensing portion, for example, as described in Japanese Patent Laid-Open No. 183145/1993,
25 Japanese Patent Laid-Open No. 283712/1993 or Japanese Patent

Laid-Open No. 194382/1994, a surface thereof is covered and protected by a silicon nitride film or a silicon oxide film and these inorganic thin films are formed by a sputtering process, a CVD process or a vapor deposition process.

5 However, the planar electrode is provided with a three-dimensional structure projected from a supporter for supporting the electrode in a plane direction (thickness is normally about 10 through 500 μm) and accordingly, coverage performance of an inorganic thin film by the vapor deposition
10 process or the CVD process is poor, particularly, it is difficult to form the inorganic thin film at side faces of the planar electrode and there is a concern that protection performance is deteriorated.

 Further, although an air flow sensor for detecting a flow
15 rate of gasoline is constituted to detect a flow rate of a gas including gasoline by detecting a temperature variation of a sensing portion produced by bringing the sensing portion in a planar shape embedded with a resistance wiring into contact with a flow path of the gas including gasoline by a change in
20 resistance of the resistance wiring, since the sensor is of a three-dimensional structure having a large stepped difference between the sensing portion and a supporter, with regard to protection of the sensing portion, a problem similar to the above-described is posed.

25 Therefore, it is conceivable to thicken the inorganic

thickness to sufficiently protect side faces of the planar electrode by the inorganic thin film, however, high stress is caused at the sensing portion and crack is caused in the film per se. Thereby, there poses a problem that the sensor characteristic is deteriorated or a position shift is caused in the resistance wiring constituting the sensor portion or a wiring on a contiguous control circuit. Particularly, in the case of a sensor in which the wiring of the resistance wiring is used for the sensing portion, as the wiring, there is used a special material which is not used in a normal semiconductor element and therefore, depending on the constituting material, adherence with a substrate material is significantly weak, for example, when the sensor element is sealed by a resin, there poses a problem that such a wiring is liable to cause the positional shift by thermal or mechanical strain.

It is conceivable to use polyimide resin or photosensitive polyimide resin on sale as the protective film of the sensing portion, however, in view of stress characteristic, heat resistance, degassing performance and compatibility with fabrication process (processing temperature or the like), there is frequently a case in which adverse influence is effected on the characteristic of the sensing portion. That is, formation of a film of polyimide resin is carried out by chemical reaction in which polyimide is formed from amic acid monomer by chemical reaction and

accordingly, residual stress is high and contamination is caused by gas components produced by the reaction. Further, a polyimide resin protective film is inferior in water proof performance and environment of using the sensor element is
5 restricted.

Meanwhile, different from the above-described sensor having the three-dimensional structure, a magnetoresistance sensor is not basically provided with a significant stepped difference, provided with a sensing portion in a planar shape
10 comprising slender wires of magnetic metal, constituted to be capable of detecting a change in magnitude or direction of a magnetic field by utilizing a magnetoresistance effect of a magnetic metal and although it is conceivable to protect the sensing portion by a polyimide resin film, however, it is
15 necessary to carry out a curing processing at high temperature, the curing temperature is higher than heat resistance limit temperature of the main body of the sensor and there poses a problem that sufficient curing processing cannot be carried out.

20 The invention has been carried out under such a situation and it is an object thereof to provide a sensor element in which particularly, a sensing portion in a planar shape is coated with a protective film excellent in step coverage, having low stress applied to the sensing portion, capable of being formed
25 at low temperature and having no concern of effecting adverse

influence to the sensing portion even in a fabrication process.

Disclosure of the Invention

According to the invention, there is provided a sensor element having a sensor substrate and a flat sensing portion supported by the sensor substrate, wherein the surface of the flat sensing portion is covered with a silicone resin film.

The silicone resin film used in the invention is provided with heat resistance against temperature in a process of fabricating the sensor element or used temperature, excellent in coverage performance, excellent in coverage performance of the flat sensing portion having the three-dimensional structure, provided with low stress performance, can be thickened and provided with high environment resistance. Further, according to the silicone resin film, different from polyimide resin used as a protective film in a semiconductor device, an amount of generating gas in curing the film is extremely small, and contamination is not caused not only at the sensing portion but also at a contiguous control circuit portion. Further, the silicone resin film exceeds polyimide resin in heat resistance, adhering performance and low stress performance. Further, the silicone resin film is more excellent than polyimide resin or a material of an inorganic film formed by a conventional CVD process or sputtering process in view of coverage performance.

The silicone resin film can be formed by coating a

1 solution of the silicone polymer and heating and curing thereof.
According to such forming method, by rotationally coating and
heating thereof, the sensing portion can be covered and
protected simply and effectively and adverse influence
5 effected to the sensing portion as in the polyimide species
protective film is resolved. Further, there is not used an
expensive film forming apparatus as in an inorganic species
protective film, which is advantageous in view of fabrication
cost. Therefore, according to the invention, there is
10 provided a method of fabricating a sensor constituted by
covering the sensing portion by the silicone resin film by
coating the solution of the silicone polymer to the flat sensing
portion supported by the sensor substrate and heating and
curing thereof.

15 Brief Description of the Drawings

Fig. 1 illustrates sectional views for explaining an
example of a structure of a magnetoresistance sensor according
to the invention and a method of fabricating thereof.

20 Fig. 2 illustrates sectional views for explaining other
example of a structure of a magnetoresistance sensor according
to the invention and a method of fabricating thereof.

Fig. 3 illustrates views for explaining a structure of
an air flow sensor of Embodiment 1 according to the invention
in which Fig. 3(a) is a plane view and Fig. 3(b) is a sectional
25 view taken along a line A-A.

Fig. 4 illustrates views for explaining a structure of an acceleration sensor of Embodiment 3 according to the invention in which Fig. 4(a) is a plane view and Fig. 4(b) is a sectional view taken along a line B-B.

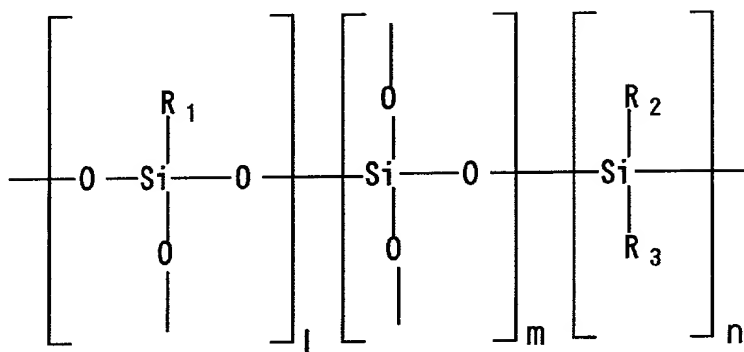
5 Best Mode for Carrying Out the Invention

According to a sensor element of the invention, a surface or a total surface of a sensing portion in each of various sensors of an acceleration sensor, a yaw rate sensor, a pressure sensor, a magnetoresistance sensor, an image sensor and the like, is covered and protected by a silicone resin film. Further, although the sensing portion in the respective sensor element is normally constituted by a plane, there may be provided more or less irregularities and the sensing portion may be formed substantially in a plane shape. Further, there may be constructed a constitution in which a silicone resin film covers not only the sensing portion but also a contiguous substrate or a peripheral circuit.

The silicone resin film comprises a cured film of silicone polymer, as the silicone polymer, it is suitable to use silicone polymer represented by the general formula (1) shown below or silicone polymer represented by the general formula (2) shown below and these may be mixtures respectively. Particularly, the silicone polymer of the general formula (2) having a ladder structure is preferable since heat resistance thereof after curing is excellent, stress applied to a

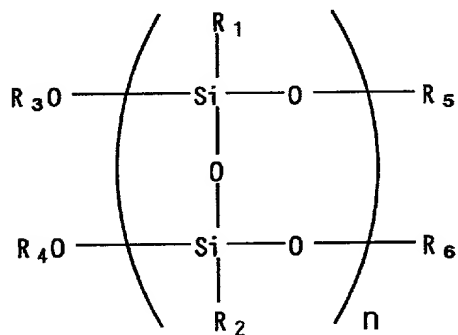
substrate material by the polymer per se is low, further, a buffer action against stress from outside is excellent.

General formula (1);



- wherein R₁, R₂, and R₃, which may be the same or different, each is aryl group, hydrogen atom, aliphatic alkyl group, hydroxyl group, trialkylsilyl group or a functional group having unsaturated bond; and l, m and n each is integers of 0 or more; and has a weight average molecular weight of not less than 1000.

10 General formula (2);



wherein R₁ and R₂, which may be the same or different, each is aryl group, hydrogen atom, aliphatic alkyl group or a functional group having unsaturated bond. Notations R₃, R₄, R₅ and R₆, which may be the same or different, each is hydrogen

atom, aryl group, aliphatic alkyl group, trialkylsilyl group or a functional group having unsaturated bond; n is an integer; and has a weight average molecular weight of not less than 1000.

Such a silicone polymer includes a polymer crosslinked
5 and cured by light of ultraviolet ray or the like. As a preferable example thereof, there is pointed out a polymer in which 1 % or more of substituent of R1, R2 and R3 is functional group having unsaturated bond in general formula (1), further, in general formula (2), there is pointed out a polymer in which
10 1 % or more of substituent of R1, R2, R3, R4, R5 and R6 is functional group having unsaturated bond. Functional group having unsaturated bond is a reaction group for crosslinking polymer molecules by crosslinking reaction or radical reaction, although alkenyl group, alkylacryloyl group, alkylmethacryloyl group or styryl group is preferable, the
15 reaction group is not limited thereto. The functional groups having unsaturated bond may be introduced by a single thereof or may be introduced as a mixture of two kinds or more thereof. Silicone polymer having such a photocrosslinking performance
20 is advantageous in fabricating a sensor element in view of capable of progressing curing reaction at low temperature with light as driving force by itself or by combining with a photocrosslinking agent, a photoinitiator or a photosensitizer and capable of reducing temperature applied
25 to the sensor element or capable of carrying out self-

TOP SECRET

patterning without using resist.

The silicone resin film according to the invention can be formed by coating a solution of silicone polymer shown by the general formula (1) and/or general formula (2), so-to-speak varnish and heating and curing thereof. As a solution of such silicone polymer, a solvent solution of alcohol species, ketone species, ether species, halogen species, ester species, benzene species, alkoxybenzene species or cyclic ketone species, is suitable. The solution of silicone polymer may be added with silane coupling agent for promoting adherence with surface of the sensing portion, polymerizing monomer for promoting density of a cured film or initiator, crosslinking agent, photosensitizer or polymerization inhibitor for promoting preservation stability. Particularly, when there is used silicone polymer having photocrosslinking performance, there may be added photocrosslinking agent, photoinitiator or photosensitizer as mentioned above. Photocrosslinking agent or photoinitiator is an adding agent for causing to cure a film by radical reaction or crosslinking reaction and as a photocrosslinking agent, there is pointed out photosensitive compound forming radical active species by light irradiation such as aromatic azide compound, aromatic bisazide compound, iminoquinonediazide compound, aromatic diazo compound, or organic halogen compound, as photoinitiator, there is pointed out carbonyl compound, dicarbonyl compound,

acetophenone, benzoin ether, acyl phosphine oxide, thioxanthone, aminocarbonyl compound or nitrogen including compound. Although temperature of curing processing differs by kind of polymer, heat resistant temperature of the sensing
5 portion or heat resistant temperature of the sensor element per se before forming the protective film, normally, 100°C through 400°C is suitable, particularly, when there is used photocrosslinking polymer, mentioned above, curing processing can be carried out at comparatively low temperature
10 of 100°C through 250°C.

An explanation will be given of a sensor element according to the invention in reference to the attached drawings as follows.

Fig. 1(g) is a sectional view for explaining an example
15 of a magnetoresistance sensor according to the invention. A sensor main body 1 is a magnetoresistance sensor constituted by a substrate 1a, a substrate insulating film 1b formed above the substrate 1a, slender lines 1c constituting a sensing portion, a wiring 1d comprising a metal wire (Al, AlSi, Cu or
20 the like) electrically connecting the slender lines 1c and a signal processing circuit (not illustrated) and a passivation film 1f comprising an inorganic film (silicon nitride film, silicon oxide film or the like) formed by a sputtering process or a CVD process and above the sensor main body 1, there is
25 formed silicone resin film 2 to cover at least the sensing

portion.

Fig. 1(a) through Fig. 1(g) are sectional views for explaining an example of a method of fabricating the magnetoresistance sensor according to the invention. First, 5 above the sensor main body 1, there is coated varnish prepared by dissolving silicone polymer shown by the above-described general formula (1) and/or general formula (2) in a solvent of alcoholic species, ketone species, ether species, halogen species, ester species, benzene species, alkoxybenzene 10 species or cyclic keton species by a film thickness of 10 nm through 50 μm , a heat treatment is carried out at 100°C through 250°C above a hot plate and the silicone resin film 2 is formed above the sensor main body 1 (Fig. 1(a)).

Next, there is coated i-line positive resist 3 having 15 a film thickness of 100 nm through 20 μm on the surface of the silicone resin film 2 (Fig. 1(b)), ultraviolet ray (i-line) is irradiated from thereabove by using a mask 4 having a contact hole pattern for exposing the bonding pad 1e or dicing lines (not illustrated) of the sensor main body 1 and the i-line 20 positive resist 3 of the contact hole portion is exposed (Fig. 1(c)).

Next, a developing processing is carried out after carrying out a baking operation after exposure to thereby provide a pattern of the i-line positive resist 3 having a 25 desired pattern (Fig. 1(d)).

With the pattern of the i-line positive resist 3 as a mask, contact holes are provided by developing the silicone resin film 2. The developing processing is carried out by carrying out dipping development or spinning development by
5 a developer exclusive for the silicone resin film and thereafter cleaning by a rinse solution exclusive for the silicone resin film (Fig. 1(e)).

Next, after removing the passivation film 1f by a dry etching process (Fig. 1(f)), the i-line positive resist 3 above
10 the silicone resin film 2 is removed in a wet state or removed in a dry state by using a reactive ion etching apparatus, an ion beam etching apparatus or an ashing apparatus, and by using an oven or a hot plate, postbaking is carried out at 200°C through 450°C to thereby cure the silicone resin film 2.
15 Thereby, there is provided the magnetoresistance sensor covered with the silicone resin film 2 a predetermined portion of which is opened (Fig. 1(g)).

According to the magnetoresistance sensor, a deterioration in the characteristic of the sensor can be
20 prevented or a positional shift of the slender wire 1c or the wiring 1d can be prevented by covering the sensor with the silicone resin film 2. According to the silicone resin film 2, residual stress is low, buffer action is provided and therefore, stress from seal resin can be buffered and the
25 positional shift or erroneous operation of the element thereby

can be prevented. Further, when there is a control circuit for controlling the sensor main body, positional shift of wirings thereof can also be prevented. Further, the resin film is provided with heat resistance capable of resisting a fabrication process of the sensor element and is excellent in environment resistance and accordingly, the resin film is effective as the protective film of the sensor main body. Further, also in evaluation of characteristic of the sensor main body by a pressure cooker test, abnormality of characteristic is not recognized.

Further, according to the silicone resin film 2, the film is formed by rotational coating and accordingly, radiation damage of the sensor main body 1 by plasma irradiation can be avoided.

Further, it is preferable to include a large amount of hydroxyl group at a surface of the passivation film 1f in order to further promote the adhering performance with the silicone resin film 2.

Further, although the sensor main body 1 is an unlimitedly used for a sensor, particularly, a magnetoresistance sensor, an air flow sensor, an acceleration sensor, a pressure sensor, a yaw rate sensor or an image sensor is used as the sensor main body 1.

Further, the sensor main body 1 may include a control circuit for controlling the sensor main body 1.

Further, for the sensing portion (slender line) 1c of the sensor main body 1, although depending on a kind of the sensor, there is used a metal such as Au, Al, Ag, Bi, Ce, Cr, Cu, Co, C, Fe, Hf, In, Mo, Mg, Ni, Nb, Pb, Pt, Si, Sn, Ti, Ta, V, W, Zn, Zr or the like, alloy, oxide, nitride, silicide, sulphide, carbide, fluoride or the like comprising the metals. For example, there is used, as alloy, Al-Cu, Al-Si, Cu-Cr, Cu-Ni, Ni-Cr, Ni-Fe, Al-Si-Cu, Ni-Cr-Si, Al-Sc, Co-Cr or the like, as oxide, Al_2O_3 , CeO_2 , CuO , Fe_2O_3 , HfO_2 , MgO , Nb_2O_5 , SiO , SiO_2 , TiO , TiO_2 , Ta_2O_5 , ZrO_2 or the like, as nitride, AlN , Cr_2N , Si_3N_4 , TiN , ZrN or the like, as silicide, CrSi_2 , $\text{MoSi}_{2.5}$, WSi_2 , $\text{Wsi}_{0.4}$ or the like, as sulphide, ZnS , as carbide, SiC , TiC , WC or the like and as fluoride, MgF_2 or the like, however, these are not limited to the above-described and any material may be used so far as the material is a material necessary for fabricating the sensor.

Further, the adhering performance between the sensor main body 1 and the silicone resin film 2 may be intensified by processing the surface of the sensor main body 1 by a solution or the like including a silane coupling agent before coating the varnish.

Further, adhering performance between the i-line positive resist 3 and the silicone resin film 2 may be intensified by processing the surface of the silicone resin film 2 by hexamethylenedisilazane or the like after coating

the varnish. Further, a reflection preventive film may be formed to form the pattern shape accurately.

Further, although according to the above-described explanation, the i-line positive resist 3 is used, so far as
5 a desired pattern can be formed, either of positive resist and negative resist may be used and any of resist for g-line, for i-line, for KrF excimer and for ArF excimer may be used.

Further, before developing the silicone resin film 2, ultraviolet ray may be irradiated to an entire face of a pattern
10 of the i-line positive resist 3 to thereby increase crosslinking density to thereby promote resistance against a developer or a rinse solution, exclusive for the silicone resin film .

Further, the silicone resin film 2 may be removed by the
15 dry etching process in place of the processing of developing the silicone resin film 2. That is, the silicone resin film 2 is cured after forming thereof to thereby constitute a cured film, thereafter, the pattern of the i-line positive resist 3 is formed by normal photolithography at an upper layer thereof
20 and with the pattern of the i-line positive resist 3 as a mask, the silicone resin film 2 and the passivation film 1f are continuously etched in a dry state by using a reactive ion etching apparatus or an ion beam etching apparatus.

Although an etching gas used in reactive ion etching is
25 not particularly limited so far as the gas is gas species

capable of etching the silicone resin film 2, a mixed gas of fluorine species gas such as CF_4 , CHF_3 or C_4F_8 and Ar or O_2 can preferably be used.

Further, when the pattern is formed by reactive ion
5 etching using an etching gas including oxygen or when the i-line positive resist 3 is removed by using an ashing apparatus, oxidation of a surface layer of the silicone resin film 2 can be reduced when the operation is carried out under a low pressure condition and a lower power condition. Particularly,
10 oxidation of the surface of the silicone resin film 2 can further be reduced by a low pressure condition equal to or lower than 1 Torr and a low power condition equal to or lower than 1 kW.

When the silicone resin film 2 is removed by the dry
15 etching process in this way, the silicone resin film 2 and the passivation film 1f can continuously be removed and accordingly, the process can be simplified.

Further, the magnetoresistance sensor may be provided with seal resin. After covering the sensor main body 1 with
20 the silicone resin film, the bonding pad 1e and a lead frame (not illustrated) are connected by a bonding wire (not illustrated) and a total of the substrate is sealed by mold resin such as epoxy resin. In this case, a control circuit for controlling the sensor main body 1 may be included on the
25 same substrate.

Further, although according to the above-described example, the silicone resin film 2 is laminated above the sensor main body 1 protected by the passivation film 1f such as a silicon nitride film or a silicon oxide film formed by a sputtering process or a CVD process to function particularly as a stress buffer coating film, the silicone polymer described in general formula (1) or general formula (2) is highly pure and therefore, the silicone resin film 2 may directly be laminated on the sensor main body which is not protected by the passivation film to thereby serve both as a protective film and a stress buffer coating film.

Further, it is preferable that the passivation film 1f includes a large amount of hydroxide group at its surface to further promote the adhering performance with the silicone resin film 2.

Fig. 2(d) is a sectional view explaining other example of a magnetoresistance sensor according to the invention. Although the constitution of the sensor main body 1 is the same as that of Fig. 1, above the sensor main body 1, there is formed a silicone resin film 13 which is photocured to cover at least the sensing portion.

Figs. 2(a) through 2(d) are sectional views for explaining other example of a method of fabricating a magnetoresistance sensor according to the invention. The method of fabricating the magnetoresistance sensor differs

from the above-described method in that there is used a compound prepared by dissolving polymer having photocrosslinking performance in a solvent and adding a photocrosslinking agent or a photopolymerization agent thereto. The silicone resin film is cured by irradiating and exposing from above by using a mask 5 having a desired pattern, removing the silicone resin film at a portion which is not irradiated with light by a developing processing and carrying out postbaking at 100°C through 250°C (Figs. 2(b) and 2(c)). When the passivation film 1f is removed by the dry etching process, there is provided the magnetoresistance sensor covered with the silicone resin film 13 which is cured optically and predetermined portion of which is opened (Fig. 2(d)).

The photocrosslinking agent or the photoinitiator is normally added for causing reaction with light as driving force and is decomposed also by a heat treatment to thereby cause curing reaction. The polymer is formed on the sensor element and therefore, a temperature condition of curing thereof directly effects adverse influence on the characteristic of the sensor, however, the polymer having high molecular weight is provided with heat resistance at 500°C even when the polymer is not thermally cured, by adding the additives, curing temperature in forming the film can be lowered and the polymer can be cured at temperature equal to or lower than heat resistance limit temperature of the sensor element. Further,

by adding the additives, photosensitivity is manifested, when a pattern needs to transcribe on the resin film, by irradiating ultraviolet ray directly to the resin film via a mask having a desired pattern and developing thereof, the pattern can be
5 formed, the resist pattern forming step can be dispensed with, the pattern can be transcribed in a short period of time and stably and accordingly, the additives can contribute to simplification and low cost formation of the process.

Embodiment 1

10 Fig. 3 illustrates views for explaining a structure of an air flow sensor of Embodiment 1 according to the invention in which Fig. 3(a) is a plane view and Fig. 3(b) is a sectional view taken along a line A-A.

An air flow sensor according to the invention is formed
15 with a metal wire 33 in a zigzag shape constituting a sensing portion above a lower support film 32 formed above a silicon substrate 31 and bonding pads 34 provided to connect to both ends of the metal wire 33 for detecting a change in an electric resistance value, an upper support film 35 is formed above
20 surfaces of these, further, the silicon substrate 31 is provided with a recess portion 36 for exposing the sensing portion and at least a surface on the rear face side of the sensing portion is covered with a silicone resin film 37.

The air flow sensor detects a flow rate of a gas by
25 detecting a heat amount of the metal line 33 which is conducted

and heated and which is deprived by depending upon the flow rate of the gas passing through the recess portion 36 by a change in the electric resistance value.

5 An explanation will be given of a method of fabricating the air flow sensor. First, after forming the lower support film 32 comprising a silicon nitride film formed by a sputtering apparatus above the Si substrate 31 having a thickness of about 300 μm , the metal line 33 comprising Pt constituting the temperature sensor, the bonding pads 34 and the upper support
10 film 35 comprising a silicon nitride film were formed in this order, a portion of the Si substrate 31 right under the metal line 33 comprising Pt was removed by a wet etching process. At this occasion, there is formed a stepped difference of 300 μm at the rear face of the sensing portion.

15 Next, the pattern of the silicone resin film 37 was formed on the surface on the rear face side of the sensing portion by the following method.

First, an aqueous solution including N-phenyl- γ -aminopropyltrimethoxysilane was rotationally coated on the
20 rear face of a silicon wafer by using a spinner at 2000 rpm, dried above a hot plate for 1 minute at 120°C to thereby carry out a surface treatment. The surface treatment is carried out to promote adhering performance with the lower support film 32.

25 Silicone polymer of general formula (1) in which 30 mol%

of side chains R1, R2 and R3 is vinyl group, remaining side chains are methyl group, l/m/n ratio is 5/3/2 and weight average molecular weight is 10000 was dissolved in methoxybenzene to constitute 25 wt% and the polymer was added with 10 weight %
5 of 1-hydroxy-cyclohexylphenylketone, 3 weight % of 3-ketocoumalin and 1 weight % of triethanolamine. The varnish was rotationally coated to the surface on the rear side of the lower support film 32 comprising a silicon nitride film subjected to the surface treatment at 3000 rpm and was subjected
10 to a heat treatment above a hot plate for 2 minutes at 130°C to thereby remove the solvent. Further, postbaking was carried out in an oven under flow of nitrogen for 1 hour at 400°C to thereby completely cure the varnish to thereby form the silicone resin film 37 having a film thickness of about
15 1 μm .

The i-line positive resist was rotationally coated on the silicone resin film 37 to constitute a film thickness of about 3 μm and normal photolithography was carried out to thereby provide i-line positive resist pattern for opening
20 desired dicing lines.

Next, with the i-line positive photoresist pattern as a mask, a portion of the silicone resin film which is not protected by the i-line positive resist, was removed by a dry etching process. The dry etching was carried out by using a
25 reactive ion etching apparatus and using a gas having a mixture

ratio of CF_4/O_2 of 7/3 as the gas for the dry etching. Further, the i-line positive resist was ashed to remove by oxygen plasma to thereby provide an air flow sensor covered with the silicone resin film 37 a predetermined portion of which was opened.

5 After forming the silicone resin film 37, the bonding pads 34 and a lead frame (not illustrated) were connected by bonding wires (not illustrated).

According to the air flow sensor, the metal line 33 comprising Pt which is conducted with electricity, is heated to temperature higher than outside temperature by about 100°C and the metal line 33 comprising Pt is deprived of heat and temperature thereof is lowered by depending upon flow intensity of gas flow. The resistance value of the metal line 33 comprising Pt is changed by temperature thereof and therefore, 10 the deprived heat amount can electrically be detected. The deprived heat amount and the flow intensity of the gas flow correspond to each other in a one-to-one relationship and accordingly, the flow of gas can be known. In the case of a sensor not covered with the silicone resin film, there poses 15 a problem that the sensor is gradually deteriorated by impurity or steam from outside air, there is a difference in the characteristic of the sensor individually, however, by coating the sensor with the silicone resin film 37, the sensor is protected from outside air, the characteristic of the sensor 20 was not deteriorated and a result of a durability test thereof 25

was at a practical level. Further, excellent characteristic of the sensor was achieved and a dispersion in the characteristic of the individual sensor was also resolved.

Embodiment 2

5 Fig. 2(g) is a sectional view for explaining a structure of a magnetoresistance sensor of Embodiment 2 according to the invention. The passivation film 1f of the sensor main body 1 is a silicon nitride film having a film thickness of about 800 nm formed by a sputtering apparatus and the silicone resin
10 film 2 was formed on the surface of the passivation film 1f by the following method.

First, silicone polymer of the general formula (2) in which 15 mol% of side chains R1 and R2 are allyl group, remaining side chains are phenyl group, side chains R3, R4, R5 and R6
15 are hydrogen atom and weight average molecular weight is 200000 was dissolved to methoxybenzene to constitute 20 wt%, further, the polymer was added with 5 wt% of 2,6-bis (4'-azidebenzal) methylcyclohexanone and 0.5 weight % of γ -aminopropyltrimethoxysilane. The varnish was rotationally
20 coated to an upper portion of the passivation film by speed of 2500 rpm, and subjected to a heat treatment above a hot plate for 2 minutes at 130°C to thereby remove solvent. There was carried out tight contact exposure via a photomask having patterns of desired bonding pads and dicing lines and unexposed
25 portions were dissolved and removed by a developer of

methoxybenzene / isopropyl alcohol = 1/4 (volume ratio) to thereby finish patterning of the silicone resin film. Further, postbaking was carried out in an oven under flow of nitrogen for 1 hour at 250°C to thereby completely cure the film and
5 the silicone resin film 2 of a film thickness of about 5 μm having a desired pattern was formed.

After forming the silicone resin film 2, the bonding pads 34 and a lead frame (not illustrated) were connected by bonding wires (not illustrated) and a total of the substrate was sealed
10 by epoxy resin. By covering the sensor main body by the silicone resin film, there were resolved positional shift of the wiring 1d comprising AlSi and the slender line 1c comprising a magnetic metal indicating the magnetoresistance effect, crack of the nitride film and deterioration of the sensor
15 characteristic accompanied thereby, which had originally been caused by stress in forming seal resin.

Embodiment 3

Fig. 4 illustrates views for explaining a structure of an acceleration sensor of Embodiment 3 according to the
20 invention in which Fig. 4(a) is a plane view and Fig. 4(b) is a sectional view taken along a line B-B.

An acceleration sensor according to the invention is provided with a silicon substrate 42 in a shape of a frame formed along a periphery of a glass substrate 41, a sensing portion
25 43 projected from the silicon substrate 42 above a plane

extended with a constant interval from the glass substrate 41 and an opposed electrode 44, contiguously arranged to the sensing portion 43, capable of forming an electric capacitance between opposed side faces of the opposed electrode 44 and the sensing portion 43. Further, a surface and side faces of the sensing portion 42 is covered with a silicone resin film 45. There are provided bonding pads 46 and 47 for respectively detecting the electric capacitance above the silicon substrate 42 in the frame shape and the opposed electrode 44. Further, contact holes 48 and 49 are provided at portions of the glass substrate above the bonding pads 46 and 47.

The acceleration sensor detects acceleration by a change in the electric capacity accompanied by a change in a distance between the side face of the sensing portion 43 and the side face of the opposed electrode 44 by displacing the sensing portion 43 in accordance with acceleration.

An explanation will be given of a method of fabricating the acceleration sensor. First, both faces of a portion of the silicon substrate having a thickness of 300 through 500 μm for constituting the sensing portion, was etched to a predetermined depth by a wet etching process and the glass substrate 41 was pasted by anodic bonding to an upper face of a portion of the silicon substrate which was not etched. Thereafter, portions of the silicon substrate other than portions constituting the silicon substrate in the frame shape,

the sensing portion and the opposed electrode, were removed to penetrate the silicon substrate to the glass substrate by wet etching to thereby form the silicon substrate 42 in the frame shape, the sensing portion 43 and the opposed electrode 44. At this occasion, there is formed a stepped difference of 300 through 500 μm at side faces of the silicon substrate 42 in the frame shape and the opposed electrode 44. The silicone resin film 45 was formed at the rear face and the side face of the acceleration sensor main body formed in this way by the following method.

First, silicone polymer of general formula (2) in which all of side chains R1 and R2 are phenyl group, side chains R3, R4, R5 and R6 are trimethylsilyl group and weight average molecular weight is 150000, was dissolved to methoxybenzene by 20 weight % relative to the solution and γ -aminopropyltrimethoxysilane was dissolved thereto by 0.5 weight % relative to the polymer to thereby prepare varnish.

The varnish was rotationally coated onto the rear face of the acceleration sensor main body at speed of 2000 rpm, subjected to a heat treatment above a hot plate for 5 minutes at 150°C to thereby remove the solvent to thereby form the silicone resin film 45 having a film thickness of about 6 μm . The i-line positive resist was rotationally coated onto the silicone resin film 45 to constitute a film thickness of about 6 μm and normal photolithography was carried out. That is,

after prebaking, the film was exposed via a photomask having a desired pattern and after exposure, baking, developing and postbaking were carried out to thereby form a desired positive resist pattern for i-line.

5 Next, with the pattern of the positive resist for i-line as a mask, by a developer of methoxybenzene /xylene = 1/4 (volume ratio), portions of the silicone resin which are not protected by the i-line positive resist, was dissolved and removed, the i-line positive resist was removed by a solvent
10 strip such as butyl acetate, thereafter, postbaking was carried out at 300°C through 450°C in an oven under nitrogen atmosphere to thereby completely cure thereof to thereby provide the silicone resin film 45 a predetermined portion of which was opened.

15 The contact holes 48 and 49 were formed at portions of the glass substrate 41 above the silicon substrate 42 in the frame shape and the opposed electrode 44 and the bonding pads 46 and 47 respectively in correspondence with the sensing portion and the opposed electrode were exposed. The bonding
20 pads 46 and 47 and a lead frame (not illustrated) were connected by bonding wires (not illustrated).

 When operation of the acceleration sensor covered with the silicone resin film 45 was confirmed, in accordance with acceleration, the sensing portion 43 was displaced in a
25 direction in which the distance between the sensing portion

T05260" E07.06860

43 and the opposed electrode 44 is changed (arrow mark direction of Fig. 4(a)). The change in the interval between the side face of the sensing portion 43 and the side face of the opposed electrode 44 was detected as a change in the electric capacitance and it was verified that there was provided a sensitivity of a sufficiently practical level.

Industrial Applicability

As mentioned above, the sensor element according to the invention is suitable for achieving promotion of reliability of the sensor main body and is suitable for being used in, for example, a magnetoresistance sensor, an air flow sensor, an acceleration sensor, a pressure sensor, a yaw rate sensor and an image sensor.

Claim(s)

1. A sensor element comprising:

a sensor substrate; and

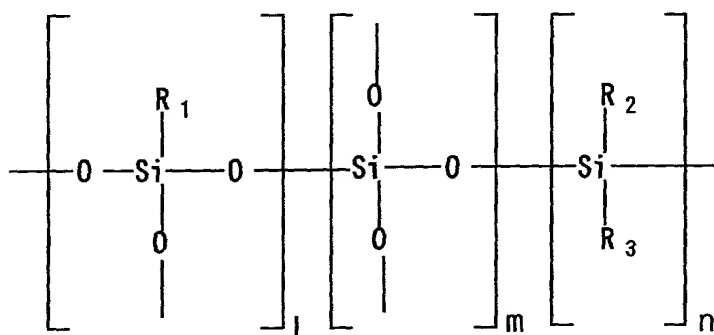
a flat sensing portion supported by the sensor substrate;

5 wherein the surface of the flat sensing portion is covered with a silicone resin film.

2. The sensor element according to Claim 1:

wherein the silicone resin film is a film of a cured silicone polymer.

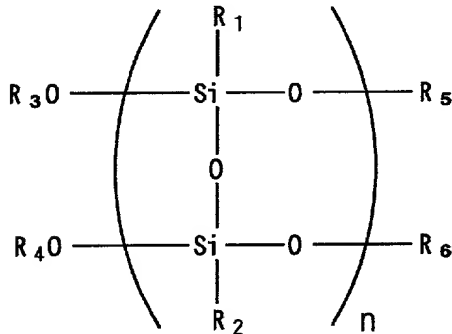
10 3. The sensor element according to Claim 2, wherein the silicone polymer is represented by the following general formula (1);



wherein R₁, R₂, and R₃, which may be the same or different, each is aryl group, hydrogen atom, aliphatic alkyl group, 15 hydroxyl group, trialkylsilyl group or a functional group having unsaturated bond; and l, m and n each is integers of 0 or more; and has a weight average molecular weight of not less than 1000.

4. The sensor element according to Claim 2:

wherein the silicone polymer is represented by the following general formula (2);



wherein R₁ and R₂, which may be the same or different, each is aryl group, hydrogen atom, aliphatic alkyl group or a functional group having unsaturated bond. Notations R₃, R₄, R₅ and R₆, which may be the same or different, each is hydrogen atom, aryl group, aliphatic alkyl group, trialkylsilyl group or a functional group having unsaturated bond; n is an integer; and has a weight average molecular weight of not less than 1000.

5. The sensor element according to Claim 3:

wherein the silicone polymer is a photocuring polymer.

6. The sensor element according to Claim 4:

wherein the silicone polymer is a photocuring polymer.

7. The sensor element according to Claim 1:

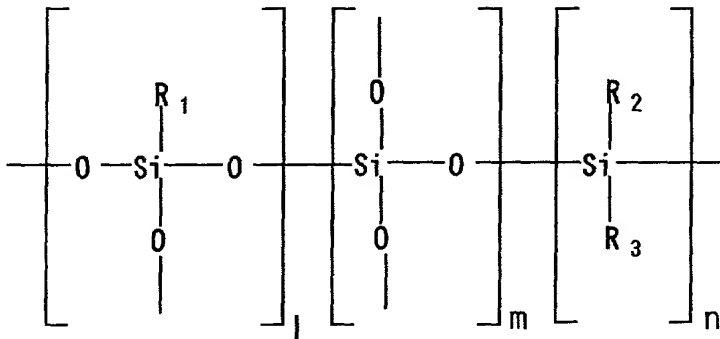
wherein the sensor element is selected from a magnetoresistance sensor, an air flow sensor, an acceleration sensor, a pressure sensor, a yaw rate sensor and an image sensor.

8. A method of fabricating a sensor element, comprising

a step of coating a solution of a silicone polymer to a flat sensing portion supported by a sensor substrate and a step of heating and curing thereof, to coat the sensing portion with a silicone resin film.

- 5 9. The method of fabricating a sensor element according to Claim 8:

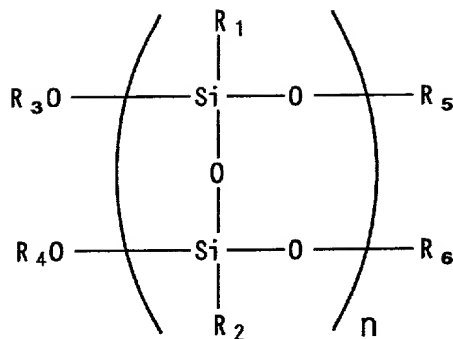
wherein the silicone polymer is represented by the following general formula (1);



- 10 wherein R₁, R₂, and R₃, which may be the same or different, each is aryl group, hydrogen atom, aliphatic alkyl group, hydroxyl group, trialkylsilyl group or a functional group having unsaturated bond; and l, m and n each is integers of 0 or more; and has a weight average molecular weight of not less than 1000.

- 15 10. The method of fabricating a sensor element according to Claim 8:

wherein the silicone polymer is represented by the following general formula (2);



wherein R1 and R2, which may be the same or different, each is aryl group, hydrogen atom, aliphatic alkyl group or a functional group having unsaturated bond. Notations R3, R4, R5 and R6, which may be the same or different, each is hydrogen atom, aryl group, aliphatic alkyl group, trialkylsilyl group or a functional group having unsaturated bond; n is an integer; and has a weight average molecular weight of not less than 1000.

11. The method of fabricating a sensor element according to Claim 9:

10 wherein the silicone polymer is a photocuring polymer.

12. The method of fabricating a sensor element according to Claim 10:

wherein the silicone polymer is a photocuring polymer.

13. The method of fabricating a sensor element according to Claim 8:

wherein the step of heating and curing is carried out at temperature of from 100°C to 250°C.

Abstract

The invention provides a sensor element having a sensor substrate and a flat sensor portion supported by the sensor substrate in which the surface of the flat sensing portion is covered with a silicone resin film. The silicone resin film is excellent in step coverage of the flat sensing portion, having low stress applied to the sensing portion, can be formed at low temperature and can prevent the sensing portion from being effected with adverse influence even in the fabrication steps.

1.05350" E0F06260

FIG.1A

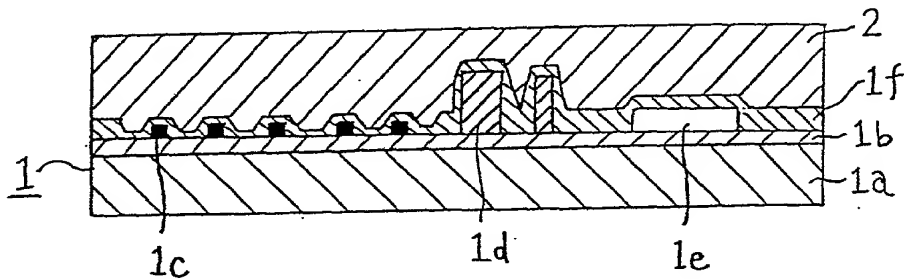


FIG.1B

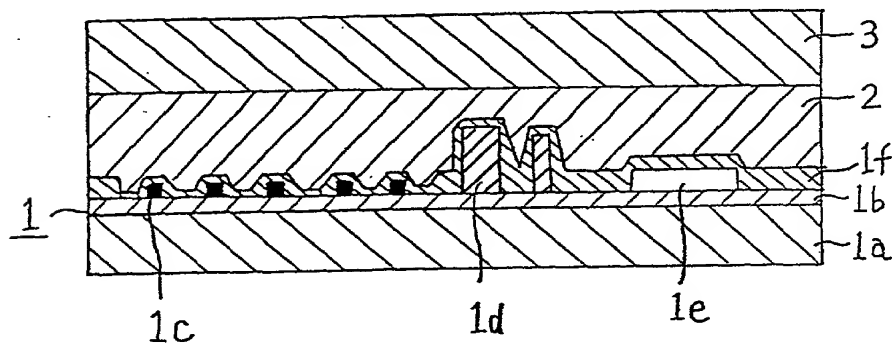


FIG.1C

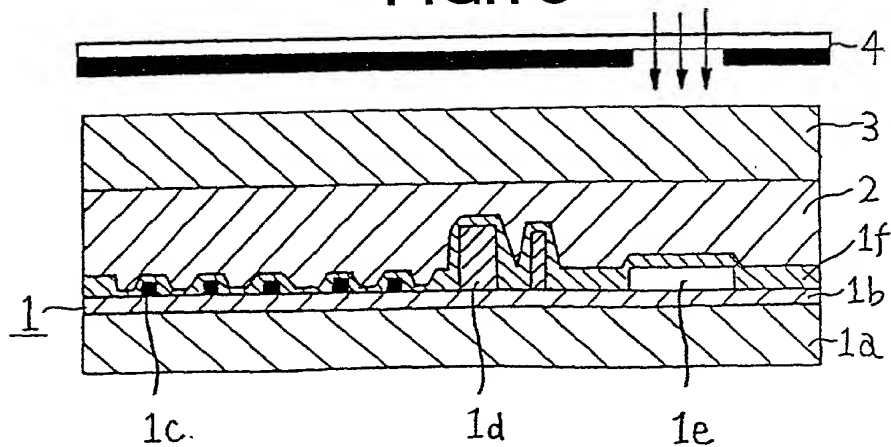


FIG.1D

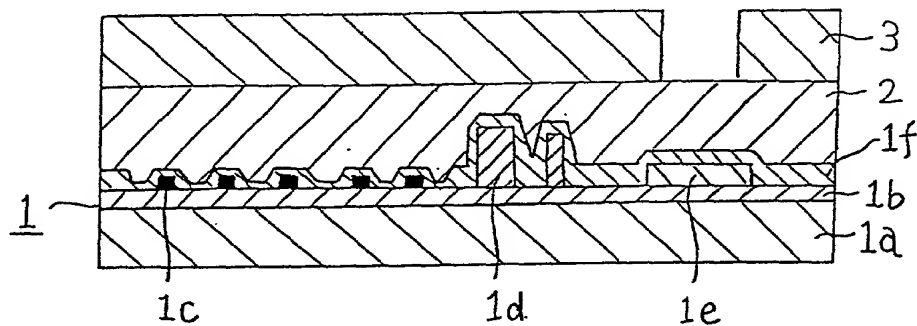


FIG.1E

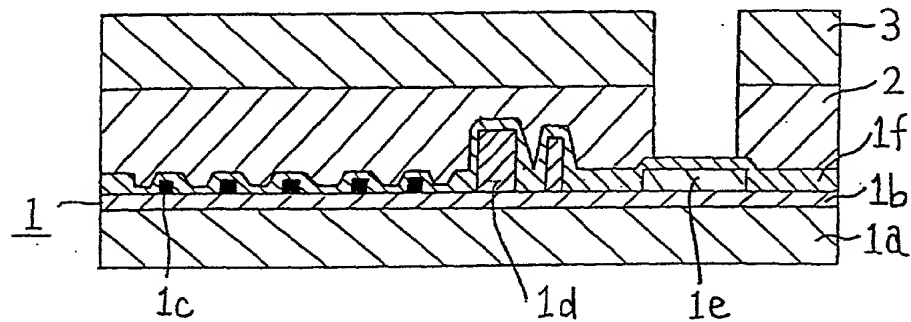


FIG.1F

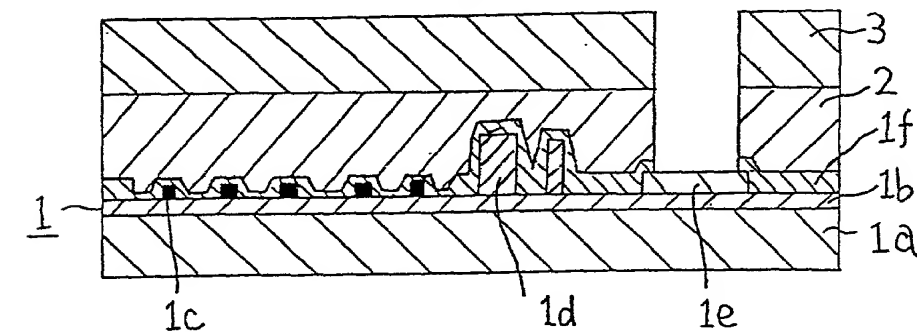


FIG.1G

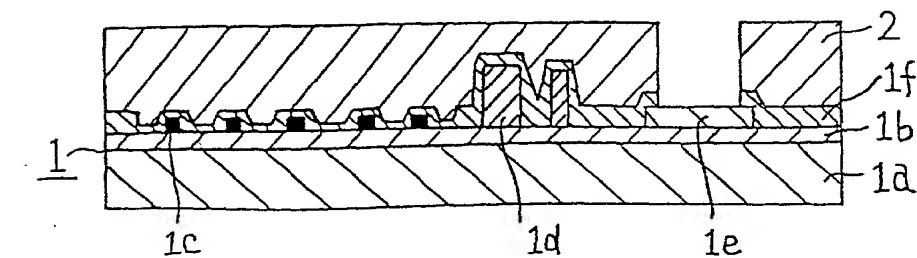


FIG.2A

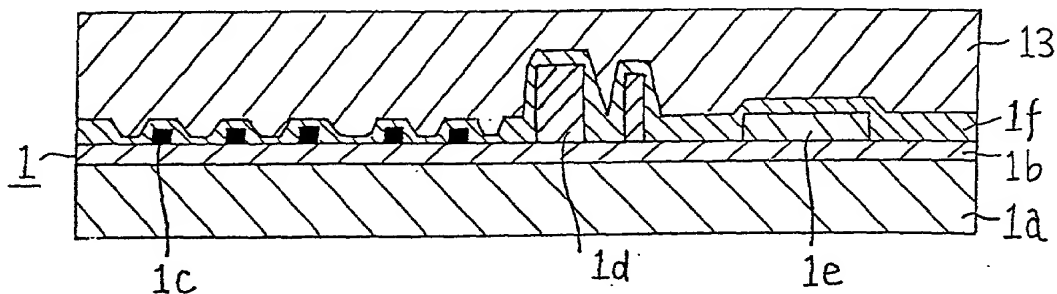


FIG.2B

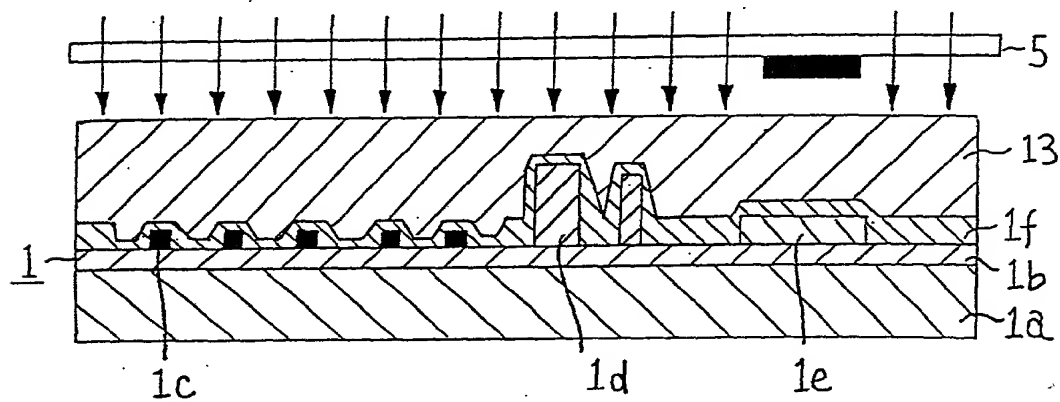


FIG.2C

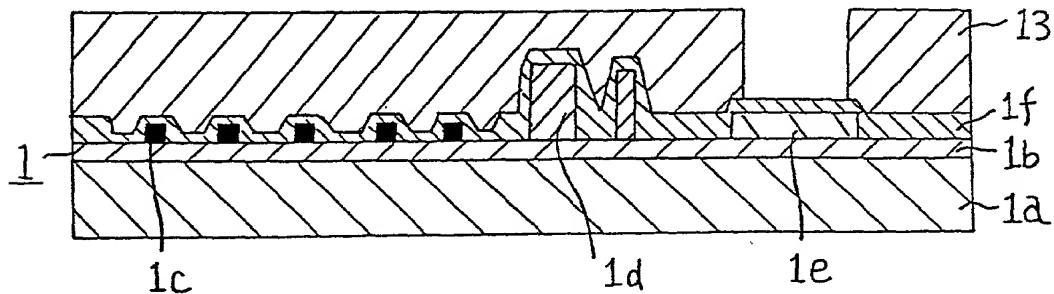
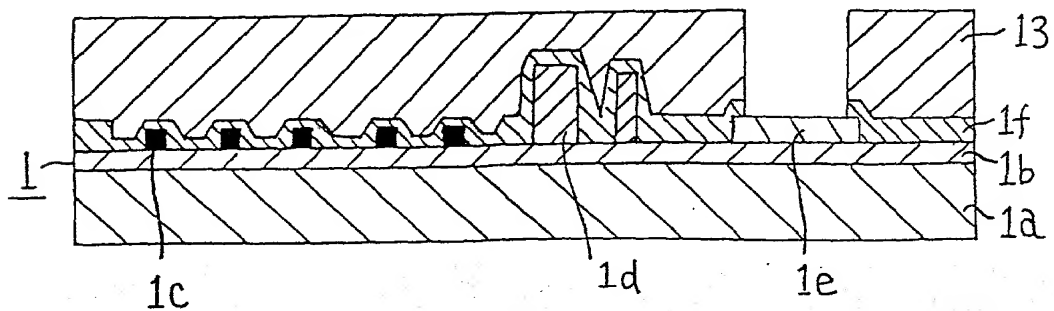


FIG.2D



"FIG. 2A" E0100000

FIG.3A

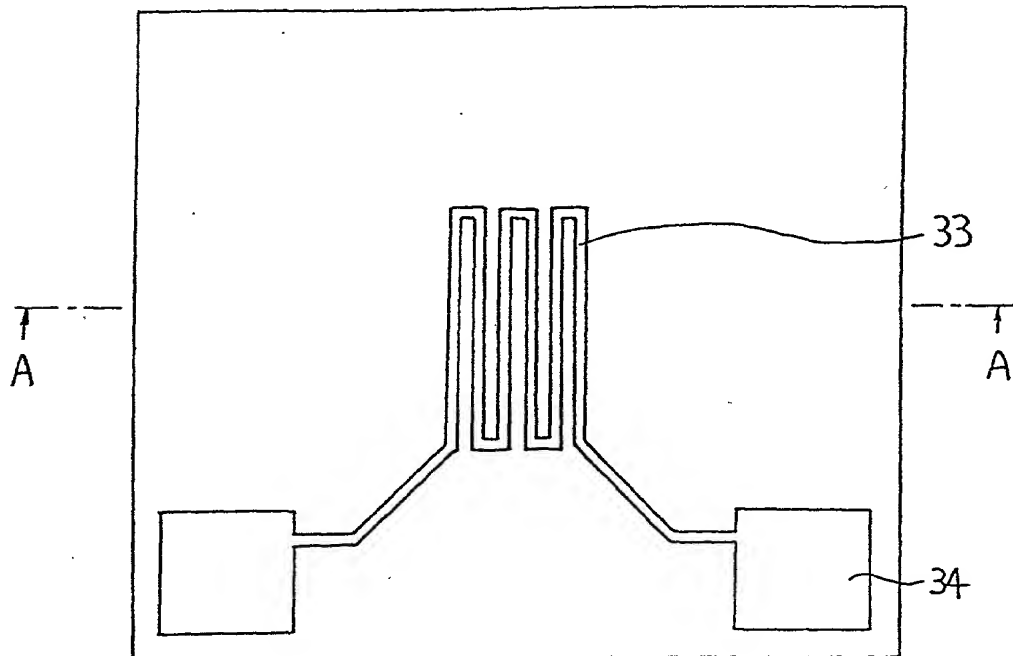


FIG.3B

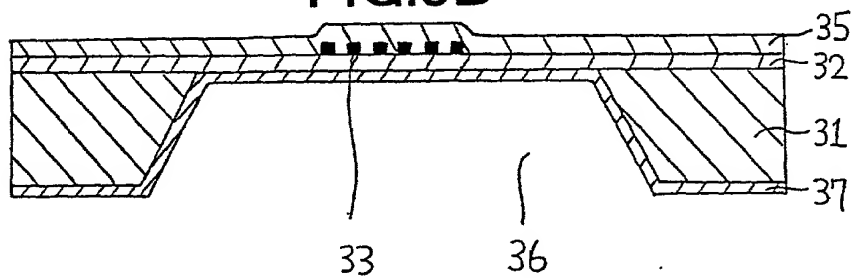


FIG.4A

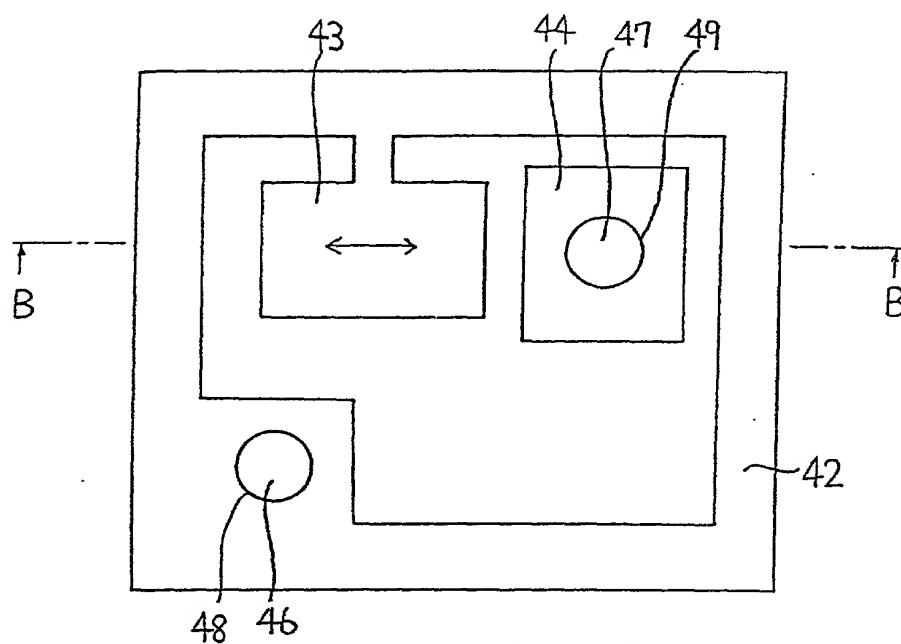
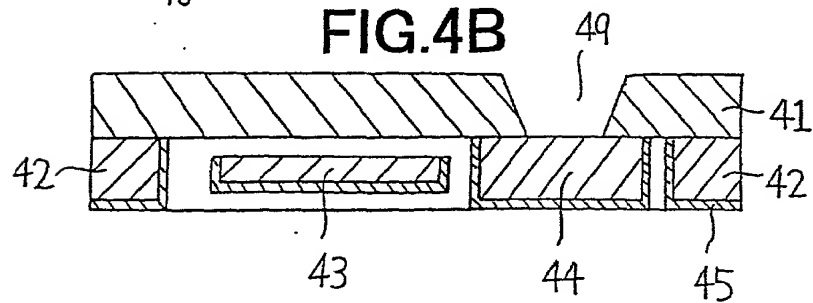


FIG.4B



Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Declaration and Power of Attorney for Patent Application

特許出願宣言書及び委任状

Japanese Language Declaration

日本語宣言書

私は、以下に記名された発明者として、ここに下記の通り宣言する：

As a below named inventor, I hereby declare that:

私の住所、郵便の宛先そして国籍は、私の氏名の後に記載された通りである。

My residence, post office address and citizenship are as stated next to my name.

下記の名称の発明について、特許請求範囲に記載され、且つ特許が求められている発明主題に関して、私は、最初、最先且つ唯一の発明者である（唯一の氏名が記載されている場合）か、或いは最初、最先且つ共同発明者である（複数の氏名が記載されている場合）と信じている。

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

SENSOR ELEMENT AND METHOD

OF FABRICATING THEREOF

上記発明の明細書はここに添付されているが、下記の欄がチェックされている場合は、この限りでない：

the specification of which is attached hereto unless the following box is checked:

☐ _____ の日に出願され、
この出願の米国出願番号またはPCT国際出願番号は、
_____ であり、且つ
_____ の日に補正された出願（該当する場合）

☒ was filed on July 26, 2001
as United States Application Number or 09/890,103
PCT International Application Number PCT/JP99/07230
_____ and was amended on
_____ (if applicable).

私は、上記の補正書によって補正された、特許請求範囲を含む上記明細書を検討し、且つ内容を理解していることをここに表明する。

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

私は、連邦規則法典第37編規則1.56に定義されている、特許性について重要な情報を開示する義務があることを認める。

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

Burden Hour Statement: This form is estimated to take 0.4 hours to complete. Time will vary depending upon the need of the individual case. Any comments on the amount of time you are required to complete this form should be sent to Chief Information Officer, U.S. Patent and Trademark Office, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner of Patents and Trademarks, Washington, DC 20231.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Japanese Language Declaration
(日本語宣言書)

私は、ここに、以下に記載した外国での特許出願または発明者証の出願、或いは米国以外の少なくとも一國を指定している米国法典第35編第365条(a)によるPCT国際出願について、同第119条(a)-(d)項又は第365条(b)項に基づいて優先権を主張するとともに、優先権を主張する本出願の出願日より前の出願日を有する外国での特許出願または発明者証の出願、或いはPCT国際出願については、いかなる出願も、下記の枠内をチェックすることにより示した。

I hereby claim foreign priority under Title 35, United States Code, Section 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT International application which designated at least one country other than the United States listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application for which priority is claimed.

Prior Foreign Application(s)
外国での先行出願

Priority Not Claimed
優先権主張なし

(Number)
(番号)

(Country)
(国名)

(Day/Month/Year Filed)
(出願日/月/年)

(Number)
(番号)

(Country)
(国名)

(Day/Month/Year Filed)
(出願日/月/年)

私は、ここに、下記のいかなる米国仮特許出願についても、その米国法典第35編119条(e)項の利益を主張する。

I hereby claim the benefit under Title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below.

(Application No.)
(出願番号)

(Filing Date)
(出願日)

(Application No.)
(出願番号)

(Filing Date)
(出願日)

私は、ここに、下記のいかなる米国出願についても、その米国法典第35編第120条に基づく利益を主張し、又米國を指定するいかなるPCT国際出願についても、その同第365条(c)に基づく利益を主張する。また、本出願の各特許請求の範囲の主題が、米国法典第35編第112条第1段に規定された態様で、先行する米国出願又はPCT国際出願に開示されていない場合においては、その先行出願の出願日と本国内出願日またはPCT国際出願日との間の期間中に入手された情報で、連邦規則法典第37編規則1.56に定義された特許性に関わる重要な情報について開示義務があることを承認する。

I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s), or 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code Section 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of application.

(Application No.)
(出願番号)

(Filing Date)
(出願日)

(Status: Patented, Pending, Abandoned)
(現況: 特許許可、係属中、放棄)

(Application No.)
(出願番号)

(Filing Date)
(出願日)

(Status: Patented, Pending, Abandoned)
(現況: 特許許可、係属中、放棄)

私は、ここに表明された私自身の知識に係わる陳述が真実であり、且つ情報と信ずることに基づく陳述が、真実であると信じられることを宣言し、さらに、故意に虚偽の陳述などを行った場合は、米国法典第18編第1001条に基づき、罰金または拘禁、若しくはその両方により処罰され、またそのような故意による虚偽の陳述は、本出願またはそれに対して発行されるいかなる特許も、その有効性に問題が生ずることを理解した上で陳述が行われたことを、ここに宣言する。

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Japanese Language Declaration
(日本語宣言書)

委任状: 私は本出願を審査する手続を行い、且つ米国特許商標庁との全ての業務を遂行するために、記名された発明者として、下記の弁理士及び/または弁理士を任命する。(氏名及び登録番号を記載すること)

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith (list name and registration number).

書類送付先



23548

PATENT TRADEMARK OFFICE

Send Correspondence to:

直通電話連絡先: (氏名及び電話番号)



23548

PATENT TRADEMARK OFFICE

Direct Telephone Calls to: (name and telephone number)

唯一または第一発明者氏名

Full name of sole or first inventor

1-00

YASUDA, Naoki

発明者の署名

日付

Inventor's signature

Date

Naoki Yasuda September 10, 2001

住所

Residence

Tokyo, JAPAN

JPX

国籍

Citizenship

JAPAN

郵便の宛先

Post Office Address

c/o Mitsubishi Denki

Kabushiki Kaisha

2-3, Marunouchi 2-Chome, Chiyoda-ku
Tokyo 100-8310 JAPAN

第二共同発明者がある場合、その氏名

Full name of second joint inventor, if any

2-00

FUKAMI, Tatsuya

第二共同発明者の署名

日付

Second inventor's signature

Date

Tatsuya Fukami September 10, 2001

住所

Residence

Tokyo, JAPAN

JPX

国籍

Citizenship

JAPAN

郵便の宛先

Post Office Address

c/o Mitsubishi Denki

Kabushiki Kaisha

2-3, Marunouchi 2-Chome, Chiyoda-ku
Tokyo 100-8310 JAPAN

(第三以下の共同発明者についても同様に記載し、署名をすること)

(Supply similar information and signature for third and subsequent joint inventors.)

第三の共同発明者の氏名 (該当する場合)	3-00	Full Name of Third Joint Inventor	TAGUCHI, Motohisa
同第三同発明者の署名	日付	Third inventor's signature	Motohisa Taguchi
住所		Date	September 11, 2001
住所		Residence	Tokyo, JAPAN JPX
国籍		Citizenship	JAPAN
郵便の宛先		Post Office Address	c/o Mitsubishi Denki Kabushiki Kaisha 2-3, Marunouchi 2-Chome, Chiyoda-ku Tokyo 100-8310 JAPAN
第四の共同発明者の氏名 (該当する場合)	4-00	Full Name of Forth Joint Inventor	KAWANO, Yuji
同第四発明者の署名	日付	Forth inventor's signature	Yuji Kawano
住所		Date	September 11, 2001
住所		Residence	Tokyo, JAPAN JPX
国籍		Citizenship	JAPAN
郵便の宛先		Post Office Address	c/o Mitsubishi Denki Kabushiki Kaisha 2-3, Marunouchi 2-Chome, Chiyoda-ku Tokyo 100-8310 JAPAN
第五の共同発明者の氏名 (該当する場合)		Full Name of Fifth Joint Inventor	
同第五同発明者の署名	日付	Third Fifth inventor's signature	
住所		Date	
住所		Residence	
国籍		Citizenship	
郵便の宛先		Post Office Address	
第六の共同発明者の氏名 (該当する場合)		Full Name of Sixth Joint Inventor	
同第六発明者の署名	日付	Sixth inventor's signature	
住所		Date	
住所		Residence	
国籍		Citizenship	
郵便の宛先		Post Office Address	